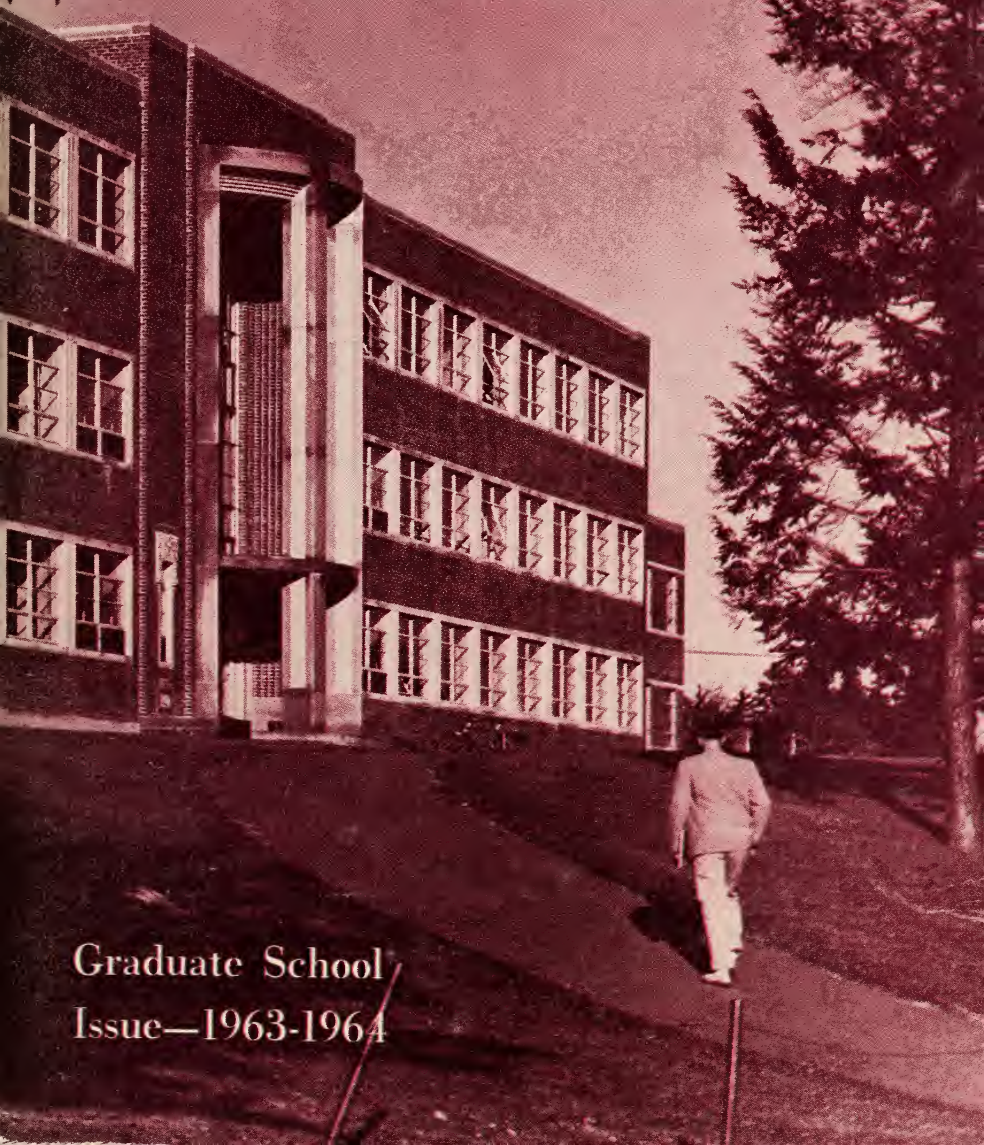


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BULLETIN OF THE UNIVERSITY OF NEW HAMPSHIRE



Graduate School
Issue—1963-1964

Correspondence

Prospective graduate students are invited to correspond with University officials as follows:

Dean of the Graduate School for application forms, the Graduate School catalogue, admissions, graduate status, graduate scholarships, transfer of credits, and programs of study.

Chairmen of Departments for further information and guidance concerning departmental course offerings, individual programs of study, and graduate assistantships.

Director of the Summer Session for information on summer course offerings.

University Alumni Executive for information concerning the Alumni Association.

University Registrar for transcripts of grades earned at the University of New Hampshire.

Director of Placement for information concerning senior or graduate placement.

The Bulletin of the University of New Hampshire is published three times in January, twice in November and December, and once in September, March, and April. Second-class postage paid at Durham, N. H.

Bulletin
of the
University of New Hampshire

CATALOGUE ISSUE
for the
GRADUATE SCHOOL
1963 - 1964

University Calendar

Summer Session

1963

June 24	Monday	Registration, eight-week session and first four-week session
June 25	Tuesday	First day of classes, eight-week session and first four-week session
July 8	Monday	Registration, six-week session
July 9	Tuesday	First day of classes, six-week session
July 22	Monday	Registration and first day of classes, second four-week session
Aug. 16	Friday	

Semester I

Aug. 29	Thursday	Last day for application for admission to graduate study for Semester I
Sept. 12	Thursday	First faculty meeting
Sept. 17	Tuesday	Registration
Sept. 18	Wednesday	Classes start
Nov. 26	Tuesday	Thanksgiving recess starts, 7:00 p.m.
Dec. 2	Monday	Classes resume, 8:00 a.m.
	Monday	Last day for filing applications for graduate scholarships for second semester
Dec. 20	Friday	Christmas recess starts, 7:00 p.m.

1964

Jan. 6	Monday	Classes resume, 8:00 a.m.
		Last day for application for admission to graduate study for Semester II
Jan. 20	Monday	Examinations begin
Jan. 25	Saturday	Examinations end

Semester II

Jan. 30	Thursday	Registration
Jan. 31	Friday	Registration
Feb. 3	Monday	Classes begin, 8:00 a.m.
Feb. 14	Friday	Last day for filing applications for graduate scholarships for academic year 1964-1965
Mar. 27	Friday	Spring recess starts, 7:00 p.m.
Apr. 6	Monday	Classes resume
May 6	Wednesday	Last day for filing applications for 1964 Summer Session graduate scholarships
May 8	Friday	Last day for presenting Ph.D. dissertation at Graduate School Office, if degree is to be granted in June
May 22	Friday	Last day for final Ph.D. oral examination, if degree is to be granted in June
		Last day for presenting completed Master's thesis to Graduate School Office, if degree is to be granted in June
May 23	Saturday	Examinations start
May 29	Friday	Examinations end
June 7	Sunday	Commencement

TABLE OF CONTENTS

	Page
UNIVERSITY CALENDAR	2
THE BOARD OF TRUSTEES	5
THE GRADUATE FACULTY	6
COMMITTEES OF THE GRADUATE SCHOOL	10
GENERAL INFORMATION	
GENERAL REGULATIONS	11
Admission; Admission to Candidacy for a degree; Registration; Graduate Credits; Graduate Work in the Summer Session; Graduate Credit for Senior Students; Unclassified Students; Incomplete Grades in the Graduate School; Departmental Requirements; Tuition; Memorial Union Fee; Changes in Rates; Graduate Assistantships; Tuition Scholarships; Hubbard Farms Fellowship in Poultry Science; George F. Dwinell Memorial Fellowship Fund of the New Hampshire Cancer Society, Inc.; Special Fellowship Programs; Reduced Tuition and Fees for Members of Staff Families; Honorary Fellowships for Visiting Scholars.	
REQUIREMENTS FOR THE MASTER'S DEGREE	16
Residence; Grades; Examinations; Transfer Credits; Thesis; Thesis Regulations.	
REQUIREMENTS FOR THE DOCTOR OF PHILOSOPHY DEGREE	18
Registration; Tuition — Regular Student; Special Research Charge for Doctoral Students; In Absentia; General Requirements; Guidance Committee; The Doctoral Committee; Qualifying Examination; Advancement to Candidacy; Dissertation; Final Examination.	
LIVING FACILITIES	21
COUNSELING CENTER	21
HEALTH SERVICE	21
MEDICAL INSURANCE	22
MEMORIAL UNION	22
TESTING AND PLACEMENT SERVICE	22
THE ALUMNI ASSOCIATION	23

	Page
DEPARTMENTAL REQUIREMENTS AND DESCRIPTION OF COURSES	24
AGRICULTURAL ECONOMICS	24
AGRICULTURAL EDUCATION	25
AGRONOMY	27
ANIMAL SCIENCE	28
BIOCHEMISTRY	29
BIOLOGY	30
BOTANY	30
CHEMICAL ENGINEERING	32
CHEMISTRY	35
CIVIL ENGINEERING	39
DAIRY SCIENCE	42
ECONOMICS	43
EDUCATION	46
ELECTRICAL ENGINEERING	56
ENGLISH	58
ENTOMOLOGY	61
FOREIGN LANGUAGES AND LITERATURES	61
FORESTRY	66
GOVERNMENT	69
HISTORY	71
HOME ECONOMICS	73
HORTICULTURE	75
MATHEMATICS	77
MECHANICAL ENGINEERING	83
MICROBIOLOGY	84
PHYSICS	85
POULTRY SCIENCE	88
PSYCHOLOGY	89
SOCIOLOGY	93
ZOOLOGY	95

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General Information

The Graduate School, which has offered instruction since 1903, has for its objective the bringing together of faculty and qualified students in a spirit of scholarship and research. The graduate student is given opportunity to specialize in some field of knowledge, and to develop a maturity of thought and attitude toward his professional field, so that both his professional and his cultural life are enhanced.

The work of the Graduate School is under the general direction of the graduate faculty. The Dean of the Graduate School is responsible for the administration of the regulations and requirements pertaining to admission, conduct of work, the granting of advanced degrees, and other pertinent matters.

Graduate programs are offered by the following departments: Agricultural Economics, Agronomy, Animal Science, Biochemistry, Biology, Botany, Chemical Engineering, Chemistry, Civil Engineering, Dairy Science, Electrical Engineering, Entomology, Forestry, Home Economics, Horticulture, Mathematics, Mechanical Engineering, Microbiology, Physics, Poultry Science, and Zoology leading to the Master of Science degree; Economics, English, Foreign Languages and Literatures, Government, History, Mathematics, Psychology, and Sociology leading to the Master of Arts degree; Education leading to the Master of Education degree; and Agricultural Education leading to the Master of Agricultural Education degree. There is also a program leading to the Master of Science for Teachers degree in the Chemistry, English, Foreign Languages and Literatures, and Mathematics departments and a program leading to the Master of Public Administration degree in the Government Department.

Graduate programs leading to the degree of Doctor of Philosophy are offered in the following departments: Botany, Chemistry, Horticulture, Microbiology, Physics, and Zoology.

Graduate students are defined as those who meet the requirements for admission to the Graduate School (see Rules and Regulations under Admission), and are registered for an approved program for graduate credit.

General Regulations

ADMISSION. Admission to the Graduate School may be granted to graduates of all colleges and universities of approved standing, provided their undergraduate records are satisfactory. Before entering upon graduate work the applicant must present evidence that he has had the necessary prerequisite training

which will enable him to pursue with benefit the courses desired. A candidate for admission must have had a cumulative undergraduate record of not less than a 2.5 grade point average*, or the equivalent, for his undergraduate program of study. In addition the candidate for admission may be required to take an achievement test, where the department in which the candidate plans to do his work so requires. These general requirements for admission to the Graduate School are in addition to the special requirements set up by individual departments or to those of the program leading to the Master of Science for Teachers degree that presupposes certification as a teacher or its equivalent. For the individual departmental requirements, see the description under the departmental offerings in this bulletin.

A student who desires to register for graduate study must submit to the Dean of the Graduate School the official application for admission to graduate study. Forms for this purpose may be obtained by writing to the Dean of the Graduate School, University of New Hampshire, Durham, New Hampshire. The application must be accompanied by two official transcripts of the student's undergraduate work and of any previous graduate work. Transcripts of applicants who are admitted to graduate study become a permanent part of the University files and will not be returned.

Applications for admission to the Graduate School should be submitted before September 1 for the first semester, before May 15 for the Summer Session, and before January 1 for the second semester to guarantee action before the respective registration days. Applications will be accepted after the dates mentioned above provided that the applications are accompanied by complete official transcripts; but it may be necessary in such instances to postpone the evaluation of credentials and the determination of requirements until after the registration period.

All regularly enrolled graduate students must have a medical history and physical examination report on file with the Director of the University Health Service. Recent graduates of the University of New Hampshire need not file a new set of reports upon being admitted to the Graduate School. Others should obtain the proper forms from the Dean of the Graduate School.

ADMISSION TO CANDIDACY FOR A DEGREE. Admission to the Graduate School does not imply admission to candidacy for a degree. No graduate student is admitted to candidacy for a degree until he has been in residence a sufficient time to enable his

* On grading scale of A equals 4.0, B equals 3.0, C equals 2.0, D equals 1.0.

instructors to judge his ability to carry on graduate work. Generally this period of time shall be not less than that required for the completion of 12 credits of graduate work for the Master's Degree, and the passing of the qualifying examination and the completion of the language requirements for the Ph.D. degree. Admission to candidacy for a degree will be determined by the Dean upon the recommendation of the department concerned. The student will be notified by the Dean, in writing, of the decision made.

REGISTRATION. A student admitted to graduate study must have his program approved by the chairman of his department or of his guidance committee and the Dean of the Graduate School. Registration is held prior to the beginning of classes each semester and on the first day of the Summer Session. Please consult the calendar on page 3 of this bulletin for the current dates of registration.

The maximum graduate load allowed is 16 semester credits for a regular semester, seven credits for a six-week Summer Session and nine credits for an eight-week Summer Session. Only under unusual circumstances will excess credits be allowed, and then only with the approval of the Dean of the Graduate School.

GRADUATE CREDITS. Graduate credits may be earned only in courses numbered from 51 through 199, and in the thesis, but graduate credits will not be given in any courses so numbered which are open to freshmen or sophomores.

GRADUATE WORK IN THE SUMMER SESSION. Graduate students who desire to do a part of their work during the Summer Session of the University will find graduate courses offered in many departments. Credit in appropriate courses may be used in fulfilling the requirements for an advanced degree. Up to 20 superior students, who have been regularly admitted to the Graduate School, may be granted exemption from Summer Session tuition. Applicants are required to submit applications no later than May 15 on a special form available at the Office of the Graduate School. For complete information on the Summer Session see the Summer Session issue of the Bulletin of University of New Hampshire.

GRADUATE CREDIT FOR SENIOR STUDENTS. Qualified senior students in the University of New Hampshire may be admitted to the Graduate School, and must have been admitted before taking courses for graduate credit. Such seniors may not substitute courses for which they registered in an undergraduate program for those for which they registered in a graduate program.

UNCLASSIFIED STUDENTS. Students holding the baccalaureate degree who have not been admitted to the Graduate School, but who wish to register for graduate courses, must receive the approval of the Dean of the Graduate School and of the instructor concerned.

INCOMPLETE GRADES IN THE GRADUATE SCHOOL. An incomplete grade in the Graduate School must be made up within a year after the course was to have been completed. This rule does not apply to the completion of the thesis.

DEPARTMENTAL REQUIREMENTS. The student must meet the special requirements of the department in which he is doing his graduate work and his program must be approved by his adviser and the Dean of the Graduate School. For these special requirements see the department statements in this bulletin.

TUITION*. The tuition is \$380 a year for residents of New Hampshire, and \$800 a year for non-residents.

Any student registering for eight credits or more per semester will pay the full semester tuition. Any student registering for fewer than eight credits per semester shall pay \$17.50 per credit hour. In certain instances Graduate Assistants may be exempted from payment of tuition. Tuition for predoctoral students is stated in the section of this bulletin devoted to the requirements of the Doctor of Philosophy degree.

MEMORIAL UNION FEE. An assessment of \$6.00 per semester must be paid by each student.

CHANGES IN RATES. The University reserves the right to adjust charges for such items as tuition, board, and room rent from time to time. Such changes will be held to a minimum and will be announced as far in advance as feasible.

GRADUATE ASSISTANTSHIPS. Approximately 100 graduate assistantships are available each year. Such assistantships are awarded only to superior students. The re-appointment of a Graduate Assistant is contingent on the maintenance of a high level of scholarship. The service required of the Graduate Assistant may be in the nature of (a) teaching assistance, (b) research assistance, or (c) general service.

Inquiries regarding assistantships should be addressed to the chairman of the department concerned.

There are two categories of regular assistantships available. The recommended conditions of employment for each category are shown on page 15.

* For tuition rates in Summer Session, see Summer Session catalogue. For tuition rates for extension courses, see University Extension Service catalogue. Tuition charges specified in this catalogue are those of the time it went to press. They are subject to change without further notice.

I. \$2200 for the academic year for 20 hours of service per week. Normal academic program: 9 semester hours per semester. Exemption from payment of tuition may be granted for the academic year and the following Summer Session on recommendation of the department chairman.

II. \$3080 (10 months at \$220, 2 months at \$440) for the fiscal year for 20 hours of service per week during 9 months, 44 hours per week for two months, with one month of vacation. Normal academic program: 9 semester hours per semester for two semesters. Exemption from payment of tuition for the regular academic year may be granted on the recommendation of the department chairman.

In addition to those already mentioned, in several departments there are assistantships which are supported by sponsored research projects. There are also teaching and research fellowships with larger stipends available to advanced students in doctoral programs.

TUITION SCHOLARSHIPS. Up to twenty superior students may be granted exemption from tuition. These awards are subject to the maintenance of a high scholastic record in the Graduate School and may be revoked at the end of any semester if the student does not merit such exemption for the subsequent semester. Foreign students will be considered for scholarship awards. Applicants are required to submit an application on a special form available at the Office of the Graduate School.

HUBBARD FARMS FELLOWSHIP IN POULTRY SCIENCE. This fellowship is provided through the generosity of Hubbard Farms, Inc., of Walpole, N. H. The grant is made in support of the graduate and research programs of the Department of Poultry Science. The fellowship is awarded annually to a student who has been admitted to the Graduate School for major work in poultry science and who has demonstrated high scholastic ability as an undergraduate, and is in need of financial assistance. If the student maintains high scholastic standing during his first year of graduate study, the award may be continued during the remainder of his graduate study at the University. The selection of the recipient of this award will be made by a committee composed of the Chairman of the Department of Poultry Science, the Dean of the College of Agriculture, and the Dean of the Graduate School. Applications for this fellowship should be directed to the Dean of the Graduate School.

GEORGE F. DWINELL MEMORIAL FELLOWSHIP FUND OF THE NEW HAMPSHIRE CANCER SOCIETY, INC. This fund is provided, on a

yearly basis, to promote the interest of young people in investigative work on growth. Selection of the recipients of these awards is determined by a University committee. Application should be directed to the Dean of the Graduate School.

SPECIAL FELLOWSHIP PROGRAMS. Graduate students at the University of New Hampshire are eligible for fellowship awards granted by the National Science Foundation, the Public Health Service, the Woodrow Wilson Foundation, and other national agencies, and for fellowships awarded under the National Defense Education Act. The University participates in the National Science Foundation Cooperative Fellowship Program and in the National Science Foundation Program of Summer Fellowships for Graduate Assistants. Information concerning these programs may be obtained at the Office of the Graduate School.

REDUCED TUITION AND FEES FOR MEMBERS OF STAFF FAMILIES. The immediate families of members of the University staff may register as full or part-time students in the Graduate School at one-half the current tuition or course rate. They are required, however, to pay the full research fee, if doctoral students.

HONORARY FELLOWSHIPS FOR VISITING SCHOLARS. Properly qualified scholars, who may desire temporarily the privileges of the library and research facilities of the University, and who are not candidates for a degree may, upon recommendation of the Dean of the Graduate School and the approval of the President of the University, be appointed Honorary Fellows without stipend. Honorary Fellows shall not be required to pay any charges except, possibly, the cost of unusually expensive supplies or equipment.

Requirements for the Master's Degree

For the degrees of Master of Arts, Master of Science, and Master of Agricultural Education, at least 30 credits must be earned, including a minimum of 18 credits in courses, or thesis, numbered from 101 through 199. The major department will prescribe for its students the courses which make up the degree program. See departmental statements for further details on requirements.

The Master of Science for Teachers degree is designed for the experienced and certified teacher who is interested in improving his understanding of the subject matter that he teaches. Thirty credits must be earned and at the discretion of the department a comprehensive final examination successfully passed. A departmental guidance committee plans the program,

subject to the approval of the Dean of the Graduate School and a special committee of the Graduate Faculty; it also administers the final examination, if required.

The requirements for the Master of Education degree, somewhat different from those above, are described on page 46.

RESIDENCE. A student will normally spend at least one academic year, or the equivalent, on the degree. No more than 12 credits, not including thesis, may be earned off campus. Of these 12, only 6 may be from another graduate school.

All graduate work for any Master's degree must be completed in not more than eight years from the time of registration for the first work taken for the degree.

GRADES. Students in the Master's degree programs must earn a grade of A or B in all courses for which a letter grade is given. The grade of Cr. (credit) is given for the thesis. Any graduate student who receives a grade of below B in nine or more credits will be required to withdraw from the Graduate School.

EXAMINATIONS. In any department or program requiring a final examination for the Master's degree, the examination may be oral, written, or both. A candidate will be permitted only two opportunities to take the final examinations for the Master's degree, and the time of these examinations will be at the convenience of the department concerned, except that all such examinations must be given at least two weeks before the Commencement date in the year in which the degree is to be conferred. Further regulations governing the final written examination, when required, will be made by the department concerned, subject to the approval of the Dean of the Graduate School. Oral examining committees, when required and not otherwise provided for, will be appointed by the Dean of the Graduate School upon the recommendation of the department concerned. The Dean of the Graduate School is, *ex officio*, a member of all examining committees.

TRANSFER CREDITS. A student may present for credit a maximum of six credits earned at another graduate school provided that these credits are of a grade of at least B or the equivalent. These will be applied toward the degree only if approved by the major department and the Dean of the Graduate School.

THESIS. A thesis may be required of candidates for the Master of Arts or the Master of Science degrees. Consult the departmental statement for thesis requirements.

The thesis must be approved by a committee of three, comprising the instructor under whose direction it was written and

two other members of the Graduate Faculty selected by the department chairman and approved by the Dean of the Graduate School.

Each department will determine the date when the candidate must submit for approval a statement of the subject of the thesis and the date when the thesis must be completed.

The number of thesis credits may vary from six to ten, subject to the approval of the student's adviser.

No thesis credit shall be given until the completed thesis has been approved by the committee on the thesis. No letter grade shall be given for the thesis, but its satisfactory acceptance will be recorded with a Cr. (credit)

THESIS REGULATIONS. The student should obtain from the Graduate School office the latest mimeographed regulations for the form and typing of theses.

Whenever a thesis is printed, it must be designated as having been accepted as a master's thesis by the University of New Hampshire.

Two copies of the approved thesis, ready for binding, shall be turned in to the Graduate School office not less than two weeks before Commencement, together with a receipt for the binding fee from the University Bookstore. Most departments require one copy of the thesis in addition to the above-mentioned two copies. (See departmental requirements in this bulletin.)

Requirements for the Doctor of Philosophy Degree

The degree of Doctor of Philosophy is conferred on qualified candidates who have passed an oral and written examination on the subject matter of their field of study, who have completed an original investigation in this field and have embodied the results in an acceptable dissertation, and who have passed on oral examination in defense of the dissertation. The degree of Doctor of Philosophy is essentially a research degree. It is not given merely for the completion of course credits. Graduate programs leading to the degree of Doctor of Philosophy are given by the Departments of Botany, Chemistry, Horticulture, Microbiology, Physics, and Zoology.

REGISTRATION. All resident predoctoral students must register each semester until requirements for the degree have been completed. The minimum requirement for the doctorate is three years beyond the bachelor's degree. Resident graduate work done at other universities may be counted toward the minimum requirement upon approval of the Guidance Committee and the

Dean of the Graduate School, but one full academic year must be in residence at the University of New Hampshire. In individual cases, the major department and the Dean of the Graduate School may grant permission to pursue the research for the dissertation at another institution where access to special facilities may be advantageous.

TUITION* — REGULAR STUDENT. The tuition is \$380 a year for residents of New Hampshire, and \$800 a year for non-residents. Any student registering for eight credits or more per semester must pay full tuition. In pursuing a program of fewer than eight credit hours per semester, he shall pay at the rate of \$17.50 per credit hour. In certain instances, graduate assistants may be exempted from payment of tuition, during the academic year and the following summer period.

SPECIAL RESEARCH CHARGE FOR DOCTORAL STUDENTS† A doctoral student who is registered for fewer than eight credits and is pursuing research for the dissertation shall pay by the credit hour, plus a research charge of \$50 a semester. If registered for research only, the charge of \$50 a semester will be applicable and will carry with it the privilege of attending seminars.

IN ABSENTIA. When a doctoral candidate completes his requirements *in absentia*, a charge of \$50 for the privilege of taking the final examination must be paid six weeks before the conferring of the degree.

GENERAL REQUIREMENTS. A student working for the Ph.D. degree must earn grades of A or B in all the courses required by his guidance committee. Certain courses may be taken for audit. A grade of Cr. (credit) is given for the completed dissertation.

GUIDANCE COMMITTEE. When the student declares his intention to proceed to candidacy for the degree of Doctor of Philosophy, the department of intended major concentration shall notify the Dean of the Graduate School, who then, upon recommendation of the department, will appoint a guidance committee. This committee will assist the student in outlining his program and in preparing him for his qualifying examination. To suit of his research and course work, the guidance committee may require him to take additional course work, with or without credit.

* Tuition charges are those of the time that this catalogue went to press. They are subject to change without further notice.

† A doctoral student is defined as one who has completed 30 graduate credits with a grade of B or better, or has received a Master's degree.

THE DOCTORAL COMMITTEE. At the time of application by the student for the qualifying examination, a doctoral committee will be appointed to supervise the qualifying and final examinations and to pass on the dissertation. This committee shall be nominated by the department of major concentration and appointed by the Dean of the Graduate School. It shall consist of a minimum of five members, usually three from the major department and two from related departments, and the Dean of the Graduate School, *ex officio*.

QUALIFYING EXAMINATION. The qualifying examination may be written or oral, or both. This examination will test: (1) the student's general knowledge in his major and minor work, and (2) his fitness for engaging in research, particularly in the subject proposed for the dissertation. The results of the examination will be communicated by the chairman of the major department to the Dean of the Graduate School.

ADVANCEMENT TO CANDIDACY. The student may not be advanced to candidacy for the Ph.D. until he has passed the qualifying examination and has completed the requirements for foreign languages to the satisfaction of the major department. The proposed subject of the student's dissertation must be declared at the time of application for advancement to candidacy. Resident full-time members of the University of New Hampshire faculty with rank of Assistant Professor or higher may not be admitted to candidacy for the Ph.D. at this University.

DISSERTATION. The dissertation must be a mature and competent piece of writing, a contribution to knowledge, embodying the results of significant and original research.

A copy of the completed dissertation must be made available to the Dean of the Graduate School and to the members of the examining committee two weeks before the final examination date. Following the examination and two weeks prior to Commencement, two copies of the approved thesis, ready for binding, shall be turned in to the Graduate Office, together with a receipt for the binding fee from the University Bookstore. Publication of the dissertation by University Microfilms will be required, and the cost will be assumed by the student. If the material presented in the dissertation is published, it should be prepared for the qualifying examination and successful pre-designated as having been accepted as a doctoral dissertation by the University of New Hampshire.

FINAL EXAMINATION. The final oral examination is conducted by the doctoral committee and is intended to give the candidate

an opportunity to defend his dissertation. A written final examination, on subject matter not covered in the qualifying examination, may also be required. This written examination is conducted by the major department. The final examinations must be completed at least two weeks prior to the date of receiving the degree. After consultation with the major department, the Dean may appoint, for participation in the final oral examination, additional members of the faculty under whom the student has worked. The doctoral committee alone shall decide on the merits of the candidate's performance by a majority vote.

Living Facilities

HOUSING. The University operates one small residence hall for graduate students. Room assignments to this hall are made in the order of receipt of the application. Requests for applications for rooms in the Graduate House or for information concerning other available housing should be made directly to the Manager of University Housing, Thompson Hall. Every attempt will be made to secure housing for graduate students.

BOARD. The University operates on a self-service basis a modern, well-appointed dining hall. Regular weekly board and cafeteria service are provided at approximately \$14.00.

Counseling Center

The Counseling Center is a University service which provides professionally qualified assistance to students who are dissatisfied with some aspect of their academic functioning or who have personal or emotional problems which interfere with their educational experience. The services of the Counseling Center are not limited to those with "serious" problems but are geared to the needs of the normal college student who seeks to achieve more personal effectiveness and greater self understanding. In addition to the direct help the Center gives to students, the staff is also available to members of the faculty and staff on a consultation basis.

Health Service

The University Health Service, located in Hood House, is devoted to the protection, improvement, and maintenance of student health. Graduate students carrying 8 or more credits, and graduate assistants, are eligible for treatment. A well-equipped out-patient clinic for diagnosis and treatment of am-

bulatory patients and a modern infirmary of 26 beds, with private and semi-private rooms, wards, and an isolation division for communicable diseases, are constantly available for students who require care. Registered nurses are on duty at all times. Hood House is open 24 hours daily during the periods when school is in session. Individual health guidance is given through personal conferences with the University Physician.

Injury and illness which require hospital confinement other than in Hood House, services of specialists, operations, ambulance service, special nurse, or special prescriptions are at the expense of the student. Bed patients at Hood House are charged \$4.00 per day. Office hours of the University Physician are from 9:00 a.m. to 4:00 p.m. daily except Saturdays and Sundays.

Student health insurance is available to graduate students, and is recommended.

Medical Insurance

In addition to the health service available through Hood House, group accident and sickness insurance giving 12 months' coverage is available to students at the University. This insurance coverage is designed to supplement the program of the University. Complete details may be had on application to the Business Office, University of New Hampshire.

Memorial Union

A "campus-center" for outside-the-classroom activities for the University community, the Memorial Union provides social, recreational, and educational meeting rooms, games rooms, and meals and snacks, as well as headquarters for a number of student organizations. The receptionist reserves rooms for organizations to meet in the Memorial Union and in other University buildings and serves as a central source of campus information. A program of activities for all students is planned by the all-student Board of Governors of the Student Union organization.

The Memorial Union is a gift of the citizens of New Hampshire, the students, the alumni, the faculty and staff, and other friends of the University. The building serves three principal purposes: as a living memorial to the men and women of the State of New Hampshire who have sacrificed their lives in our armed forces, as a college union, and as a state-wide conference center.

Testing and Placement Service

The placement services of the Testing and Placement Service are available to all degree candidates who have completed at

least 12 semester hours of graduate work and have been accepted to degree candidacy by the Graduate School. The testing services, offering the Graduate Record Examination and the Miller Analogies Test, as well as other tests for graduate schools, are also available through the Service by special appointment.

The Alumni Association

Those individuals who have received an advanced degree from the University of New Hampshire automatically become members of the Alumni Association. The present membership of the Association exceeds 21,000 men and women who represent New Hampshire College and University of New Hampshire classes from 1883 through the present. Alumni reside in every state of the Union as well as in many foreign countries.

Governed by a Board of Directors of 15 elected and 2 *ex officio* members, the alumni are organized by classes and clubs. Class reunions are held annually. An annual Homecoming Day in the fall provides opportunity for alumni to return to Durham while the University is in session. Other alumni gatherings on campus are also scheduled from time to time during the academic year. There are 45 UNH alumni clubs throughout the United States. A monthly magazine, *The New Hampshire Alumnus*, circulates news of students, faculty, alumni, and the University to Association subscribers. From Alumni Offices in Alumni House on Garrison Avenue, the Association's activities are directed by a permanent Alumni Executive and his staff.

Departmental Requirements and Description of Courses

If the numerals designating a course running through both semesters are connected by a hyphen, the first semester's work, or its equivalent, is a prerequisite to the second. If the numerals are separated by a comma, properly qualified students may take the second semester's work without having had the first.

Courses numbered 51 through 99 are open to graduate and advanced undergraduate students. Courses numbered from 101 through 199 are open only to those admissible to graduate study.

The Graduate School reserves the right not to offer an announced course when valid reasons arise.

AGRICULTURAL ECONOMICS

WILLIAM F. HENRY, *Chairman*

Admission to graduate study in Agricultural Economics may be granted those who have satisfied the requirements for admission to the Graduate School and present evidence of satisfactory undergraduate training. Normally, this will include 9 or more credits in economics, including Agricultural Economics, as evidence of aptitude for advanced training in the field. Candidates for the Master's degree will be required to pass a final examination and present an acceptable thesis.

51. AGRICULTURAL BUSINESS. The organizational, legal, and financial aspects of businesses engaged in buying farm products and selling farm supplies. Farm cooperatives are covered as a special case. Agricultural marketing problems are integrated with the course content. Mr. Grinnell. 3 lec.; 3 cr.

54. AGRICULTURAL FINANCE. The capital needs of different kinds of farms and farmer organizations. Saving, credit, renting, partnerships, and other means of obtaining capital. Organization, practices, and problems of credit institutions serving agriculture. The valuation and appraisal of farm property. *Prereq.*: Agricultural Economics 14 or concurrently. Mr. Andrews. 2 lec.; 2 cr. (Alternate years; offered in 1963-64.)

55. AGRICULTURAL MARKETING. Food processing and distribution comprise one of the world's most important industries. This course examines the marketing structure for the major food industries and the kinds of market decisions and agreements made for profit and general welfare by firms, processors, and government policy makers. Consideration is given to market development, plant location, prices, grades, and specification buying as related to the demand for food by institutional buyers, processors, and retailers. Emphasis is given to international trade in food products and the

place of the surplus productive capacity of the United States in relation to world trade. Mr. Bowring. 3 lec.; 3 cr.

61. AGRICULTURAL POLICY. The study of problems which are the basis for government and private policies in the production and marketing of agricultural products. Prices, production controls, marketing agreements, conservation, and farm credit are appraised relative to the objectives of agriculture and the concept of general welfare. Mr. Drew. 3 lec.; 3 cr.

63, 64. SEMINAR. Presentation and discussion of reports on economic theory and current economic topics with departmental staff. *Prereq.*: Junior standing. May be repeated. 1 lec.; 1 cr.

67-68. SPECIAL PROBLEMS IN AGRICULTURAL ECONOMICS. Special assignments in readings and problems to satisfy students' needs. Mr. Henry, Mr. Bowring, Mr. Drew, Mr. Andrews, Mr. Grinnell. 1-3 cr.

72. RESEARCH METHODOLOGY. Designed to teach the scientific method of research to advanced students. Emphasis will be placed on the meaning of logic and the scientific method and on the application of research techniques to identifying and solving problems. *Prereq.*: 3 hours of statistics. Mr. Drew. 3 lec.; 3 cr.

75. LINEAR PROGRAMMING METHODS. The course covers setting up and solving problems by the simplex and distribution methods, variations in linear programming problems, solving input-output and game theory problems, and parametric programming. Situations dealt with include least cost combinations, such as feed and gas mixing, maximum profit combinations, transportation and spatial equilibrium, and intersector flows from producer to consumer. *Prereq.*: Mathematics 7 or permission of instructor. Mr. Andrews. 3 lec.; 3 cr.

104. ECONOMICS OF PRODUCTION AND RESOURCE USE. Principles of choice, resource use, and farm production under perfect and imperfect knowledge. Relationships between resources and products, nature of costs, returns to scale, factor valuation and pricing, and uncertainty are appraised to managing land, labor, and capital resources for achieving efficient resource use. Mr. Andrews. 3 cr.

107. STATISTICS FOR AGRICULTURE. Use of statistical tools in measurement and analysis of data. Assigned problems and conferences. Mr. Bowring. 3 cr.

181-182. READING AND RESEARCH IN AGRICULTURAL ECONOMICS. With the advice and consent of the instructor, a student, prepared by training and experience to do independent work, may register for a reading and research course. The student will undertake assigned problems and readings under guidance of the instructor. Mr. Henry, Mr. Bowring, Mr. Drew, Mr. Andrews, Mr. Grinnell. 1-3 cr.

THESIS. To be arranged. 6-10 cr.

AGRICULTURAL EDUCATION

WILLIAM H. ANNIS, *Program Chairman*

Students majoring in Agricultural Education are expected to have had sufficient undergraduate work in this field to fulfill the requirements for state certification as a teacher of Voca-

tional Agriculture or to be desirous of meeting such qualifications through graduate study. Students wishing minor concentration in this area will be accepted.

The program is offered during the Summer Session only. The sequence of courses will cover a period of four summers and will then be repeated.

A comprehensive examination will be required of all candidates for the degree. Thesis is optional.

101. **ADVANCED METHODS IN FARM MECHANICS INSTRUCTION.** A study of the farm mechanics' problems and how to approach it in the high school. Consideration will be given from the standpoint of its place as a part of the course of study in Vocational Agriculture. The physical setup, as well as the processing of supplies and equipment, methods of supervision and direction of farm mechanics projects, and the preparation and presentation of demonstrations will be included. Mr. Gilman. 2 cr. (Offered in 1965.)

102. **METHODS IN TEACHING THE OPERATION AND MAINTENANCE OF FARM TRACTORS.** Methods of teaching the servicing and maintenance of the various mechanical systems found on farm tractors. Teaching plans, techniques of instruction, and essential skills will be considered. Demonstrations, discussions, and laboratory participation will make up a considerable part of the class work. Mr. Gilman. 2 cr. (Offered in 1963.)

103. **METHODS IN TEACHING THE CARE AND MAINTENANCE OF FARM MACHINERY.** Course content includes: Methods in teaching the care and maintenance of farm machinery, teaching plans, techniques of instruction, and the essential skills. Demonstrations, discussions, and laboratory participation will make up the balance of the work in this course. Mr. Gilman. 2 cr. (Offered in 1964.)

104. **PROGRAM PLANNING IN VOCATIONAL AGRICULTURE.** The gathering of basic community data; its interpretation and evaluation will be considered. The data obtained will serve as the basis for the preparation of the long-time plan, annual plan, and course of study for the local department of vocational agriculture. Mr. Annis. 2 cr. (Offered in 1965.)

105. **SUPERVISED FARMING IN VOCATIONAL AGRICULTURE.** The course will cover developing of cooperative relations, selecting and developing individual programs with the students, and the supervision and evaluation of such programs. Mr. Annis. 2 cr. (Offered in 1966.)

106. **PREPARATION AND USE OF VISUAL AIDS FOR TEACHING VOCATIONAL AGRICULTURE.** The purpose of visual aids and the kinds best adapted to use in the program, together with their preparation and use, will be given primary consideration in this course. 2 cr. (Offered in 1966.)

107. **ORGANIZATION AND SUPERVISION OF THE FUTURE FARMERS OF AMERICA PROGRAM.** The purposes and organization of the Future Farmers of America, establishing the local chapter, planning and developing a program of work, ways and means of improving the local chapter, together with methods of evaluation will be covered. 2 cr. (Offered in 1966.)

108. **ORGANIZING, TEACHING, AND SUPERVISING ADULT EDUCATION PROGRAMS.** The techniques of organization, program planning, methods of teaching, and methods of supervision as they apply to instruction with out-

of-school groups will be given consideration. Mr. Annis. 2 cr. (Offered in 1963.)

109. COMMUNITY ORGANIZATION AND PUBLIC RELATIONS. A study of the composition, purposes, and objectives of the various social and economic organizations operating in local communities; importance of their membership to the general welfare of the area and the development of a public relations program for a teacher of agriculture to promote the program of vocational agriculture on the local, state, and national level. 2 cr. (Offered in 1964.)

110. PHILOSOPHY OF VOCATIONAL EDUCATION. A study of the development of vocational education in the United States with emphasis on the socio-economic influences responsible for its establishment. Its relationship with general education, together with the coordination of instructional programs in the various vocational fields. 2 cr. (Offered in 1964.)

111, 112, 113. RESEARCH IN AGRICULTURAL EDUCATION. Individual study problems in various phases of agricultural education. *Prereq.*: Permission of staff. 2 cr.

AGRONOMY

ALLAN B. PRINCE, *Chairman*

Before students are admitted to graduate study in Agronomy they must have had basic courses in soils and crops as well as adequate preparation in the biological and physical sciences. A candidate for the Master's degree shall pass an oral or written examination covering his graduate courses and thesis.

(51). PASTURE-HAY CROPS AND TURF MANAGEMENT. The grasses and legumes used as hay, pasture, and silage, and the methods used in production of high quality forage. Consideration also will be given to turf grasses and management of lawns and turfs. Mr. Higgins. 3 lec.; 1 lab.; 4 cr.

52. A REVIEW OF AGRONOMY. Principles and practices in agronomic crop production, including the management of soils and the use and response of lime and fertilizers. For teachers of Vocational Agriculture and other students with the permission of the advisors. Staff. (Summer Session only; not offered in 1963.) Two hours daily lec. and lab.; 2 cr.

57. PHYSICS AND CHEMISTRY OF SOILS. Physical and chemical properties of soils; their measurement and relation to structure; water movement; temperature; and liberation, absorption, and fixation of elements in soils. Mr. Prince. *Prereq.*: Biochem. 1 or Chem. 17 or their equivalent. 3 lec.; 2 lab.; 5 cr. (Alternate years; not offered in 1962-63.)

58. SOIL CLASSIFICATION AND MAPPING. The genesis, morphology, classification, and mapping of soils. Mr. Peterson. *Prereq.*: Agronomy 11, and Geology 1 or 7, or permission of instructor. 2 lec.; 1 lab.; 3 cr. (Alternate years; offered in 1963-64.)

62. BREEDING OF FIELD CROPS. Principles and methods of breeding of grasses, legumes, and cereal crops. The genetic basis of breeding will be emphasized. Laboratory will consist of genetic problems, crossing and inheritance studies in the greenhouse, and statistical analysis of experimental

plot designs. Mr. Dunn. *Prereq.*: Zoology 61. 2 lec.; 1 lab.; 3 cr. (Alternate years; offered in 1963-64.)

71, 72. AGRONOMY SEMINAR. Library and reference work on special phases of soil and crop problems. Practice in consulting literature and in preparation and presentation of reports and abstracts. Required each semester of seniors and graduate students majoring in agronomy; elective for other qualified students. Staff. 1 cr.

75, 76. INVESTIGATIONS IN

- a. Crop Production — Mr. Higgins
- b. Plant Breeding — Mr. Dunn
- c. Physics and Chemistry of Soils — Mr. Prince
- d. Soil Fertility — Mr. Peterson

Elective only after consultation with the instructor in charge. Hours to be arranged. 1-4 credits.

104. ADVANCED SOIL CHEMISTRY. Lectures, discussions, and problem work in laboratory. Physical chemistry of soils and soil colloidal phenomena. Anion and cation exchange mechanisms in soils. Theories of swelling. Crystallographic properties of the clay colloids and their relation to cation and anion exchange. The nature of soil acidity. Oxidation-reduction phenomena in soils. Mr. Prince. *Prereq.*: Agronomy 57, and Chemistry 17, or permission of instructor. (At least one semester of physical chemistry recommended.) 3 cr.

105, 106. RESEARCH TECHNIQUES.

- a. Crop Production — Mr. Higgins
- b. Plant Breeding — Mr. Dunn
- c. Soil Fertility — Mr. Peterson

Elective only after consultation with the instructor in charge. Hours to be arranged. 1-4 credits.

THESIS. A thesis study of some phase of Soil Science or Plant Science is required of all candidates for an advanced degree. 6 to 10 cr.

ANIMAL SCIENCE

GERALD L. SMITH, *Acting Chairman*

Students admitted to graduate study in Animal Science are expected to have had satisfactory undergraduate training in Animal Science, Dairy Science, or other biological sciences. Candidates majoring in Animal Science will be required to pass an oral examination and prepare a thesis.

51. ANIMAL BREEDING. The principles and practices of breeding farm animals, including cross-breeding, in-breeding, selection, inheritance, breed analysis, reproductive efficiency, fertility, sterility. Mr. Smith. 3 lec.; 3 cr.

52. ANIMAL SCIENCE SEMINAR. Library and reference work and the preparation of papers on various Animal Science subjects. Mr. Tirrell. Hours and credits to be arranged.

60. A REVIEW OF ANIMAL HUSBANDRY. The principles and practices relating to the feeding, breeding, selection and management of beef cattle,

horses, sheep, and swine. For teachers of vocational agriculture and other students with the permission of their advisers. Two hours daily lec. and lab.; 2 cr. (Alternate years; not offered in 1963-64.)

105. **PROBLEMS IN ANIMAL BREEDING.** Studies in practical breeding problems with beef and dual-purpose cattle, sheep, horses, and hogs. The genetic principles important to successful livestock production will be emphasized. Mr. Tirrell and Mr. Smith. 2 lec.; 1 lab.; 3 cr.

106. **MEATS, LIVESTOCK MARKETS, AND PRODUCTS.** The essential factors in meat selection, cutting, curing, and smoking; study and discussion relative to the problems of livestock marketing and the procedure in the large central markets. Trips are taken to various packing plants. Mr. Smith. 2 lec.; 1 lab.; 3 cr.

BIOCHEMISTRY

EDWARD J. HERBST, *Chairman*

Students admitted to graduate study in Biochemistry are expected to have had preparation in the biological sciences, in mathematics, in physics, and in general analytical, and organic chemistry. The candidate for the M.S. degree will be required to prepare a thesis, and to pass an oral examination covering his graduate courses and thesis.

51-52. **GENERAL BIOCHEMISTRY.** The chemistry of fats, carbohydrates, and proteins; colloids, enzymes, digestion, metabolism, and excretion. Mr. Shimer, Mr. Teeri. *Prereq.*: Satisfactory preparation in organic chemistry and quantitative analysis. 3 lec.; 2 labs.; 5 cr.*

56. **PHYSIOLOGICAL CHEMISTRY.** The qualitative and quantitative methods fundamental to medical diagnostic work. The chemistry of fats, carbohydrates, and proteins; enzymes, digestion, metabolism, and excretion. Mr. Teeri. *Prereq.*: Satisfactory preparation in organic chemistry and quantitative analysis. 3 lec.; 2 lab.; 5 cr.

101-102. **ADVANCED BIOCHEMISTRY.** An advanced study of the fundamental principles of biochemistry. Mr. Teeri, Mr. Routley, Mr. Herbst. 2 lec.; 2 cr.

103, 104. **SPECIAL PROBLEMS.** Staff. *Prereq.*: Satisfactory preparation in analytical, organic, and biological chemistry. Subject matter and credits to be arranged.

105, 106. **BIOCHEMISTRY SEMINAR.** Reports and discussions of biochemical literature and recent developments in biochemistry. Mr. Herbst. *Prereq.*: Permission of the Department Chairman. 1 cr.

107, 108. **ADVANCED BIOCHEMISTRY LABORATORY.** An advanced laboratory course with special emphasis on the methods used in biochemical research. Mr. Herbst and staff. *Prereq.*: Permission of the Department Chairman. 1 lec.; 2 lab.; 3 cr.

THESIS. To be arranged. 6-10 cr.

* Under special conditions a graduate student may register for the lectures in this course (3 credits) after obtaining the consent of the instructor and the approval of the student's adviser.

BIOLOGY

GEORGE M. MOORE, *Chairman of Committee*

Students admitted to graduate study in Biology must have completed an undergraduate major in Biology or in some field of the biological sciences. Suitable training in the physical sciences is also necessary. Students who lack undergraduate training in any of the fields of the biological sciences may be required to complete certain courses in these fields which do not carry graduate credit before they are admitted to candidacy for a degree.

Graduate work in Biology is under the direction of a committee consisting of the Chairmen of the Departments of Microbiology, Botany, Entomology, and Zoology. This committee shall determine, in light of the student's objectives, the courses and requirements to be met by the candidate. Candidates for the Master's Degree in Biology shall pass an oral examination covering their general preparation in the field, and the thesis. With the permission of the Committee mentioned above and the prospective Supervisor of the Thesis, a student may elect to submit a thesis in partial fulfillment of the requirements of the Master's degree. The number of thesis credits will be six.

91. BIOLOGY-EDUCATION. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL BIOLOGY. Objectives and methods of teaching; the selection and organization of materials; the preparation of visual aids; the setting up of aquaria and other projects. The use of the field trip as a tool in teaching high school biology. Mr. Schaefer. *Prereq.*: Two years of biological sciences and Principles of Teaching. 2 rec.; 1 lab. or field trip; 3 cr.

For listings of other courses see: Botany, Entomology, Microbiology and Zoology.

BOTANY

ALBION R. HODGDON, *Chairman*

Students admitted to graduate study in Botany are expected to have had adequate preparation in basic Botany courses and in the physical sciences. The candidate for the M.S. degree will be required to pass an oral examination and to prepare a thesis. Thesis credits may be from 6 to 10 depending on the research problem involved. Students who are working toward the Ph.D. degree must demonstrate a reading knowledge of two foreign languages, preferably French and German, and must complete a thesis-dissertation on some original research in Botany. The subject-matter fields for graduate study in Botany are: Systematic Botany and Plant Ecology, Mr. Hodgdon; Plant Physiology, Mr. Dunn; Plant Morphology and Anatomy, Miss Nast;

Plant Pathology, Mr. Rich, and Mr. Kilpatrick; Mycology, Mr. Richards; Cytology, Mr. Schreiber.

51. PLANT PATHOLOGY. The nature of disease in plants, the etiology, symptomatology, and classification of plant diseases. Mr. Rich. *Prereq.*: Bot. 1 or Bio. 1. 1 lec.; 2 lab.; 3 cr.

52. PRINCIPLES OF PLANT-DISEASE CONTROL. Exclusion, eradication, protection, and immunization, and the specific, practical methods used to control plant diseases. Mr. Rich. *Prereq.*: Botany 51. 1 lec.; 2 lab.; 3 cr. (Alternate years; offered in 1963-64.)

53. PLANT ANATOMY. The anatomy of vascular plants with special emphasis upon tissue development and structure. Miss Nast. *Prereq.*: Bot. 1 or Bot. 3. 1 lec.; 2 lab.; 3 cr.

54. CYTOLOGY. The structure, physiological behavior, and development of cells. The cellular basis of heredity. Mr. Shreiber. *Prereq.*: two years each in the biological sciences and in chemistry. 3 lec.; 3 cr.

55. ADVANCED SYSTEMATIC BOTANY. The principles and laws of plant classification and nomenclature; study of plant families, field, and herbarium work. Mr. Hodgdon. *Prereq.*: Botany 6. Hours to be arranged. 3 cr. (Not offered in 1963-64.)

56. PLANT PHYSIOLOGY. Structure and properties of cells, tissues, and organs; absorption and movement of water; metabolism; growth and irritability. Mr. Dunn. *Prereq.*: Bot. 1 or Bot. 3, and one year of Chemistry. 2 lec.; 2 lab.; 4 cr.

57, 58. INVESTIGATIONS IN (a) SYSTEMATIC BOTANY, (b) PLANT PHYSIOLOGY, (c) PLANT PATHOLOGY, (d) PLANT ANATOMY AND MORPHOLOGY, (e) PLANT ECOLOGY, (f) AQUATIC PLANTS, and (g) CYTOLOGY. Elective only upon consultation with the Chairman of Department. Mr. Hodgdon, Mr. Dunn, Mr. Rich, Miss Nast, Mr. Schreiber. Hours to be arranged. 2 to 6 credits.

59, 60. BOTANY SEMINAR. Library reference work and the preparation of papers and abstracts on special phases of botany. Practice in the preparation of oral and written reports. Botany staff. *Prereq.*: 6 hours of botany, or permission of the Chairman of the Department. This course may be repeated for credit. 1 rec.; 1 cr.

62. MORPHOLOGY OF THE VASCULAR PLANTS. Life histories and evolution of both extinct and living pteridophytes, gymnosperms and angiosperms, including comparisons of the general structure and sexual organs. Miss Nast. *Prereq.*: Bot. 1 or Bot. 3. 2 lec.; 2 lab.; 4 cr. (Alternate years; offered in 1962-63.)

64. MICROTECHNIQUE. A methods course in embedding, sectioning, and staining plant tissues, and introduction to microscopy. Miss Nast. *Prereq.*: Botany 1 or Botany 3. 3 cr.

68. MYCOLOGY. Studies of the parasitic and saprophytic fungi, their growth, reproduction, and identification. Mr. Richards. Laboratory and assigned reading. 1 lec.; 2 lab.; 3 cr.

101. PLANT GEOGRAPHY. The distribution of plants, a consideration of vegetation types and floras and problems of endemism with emphasis on

North America; the major influential factors such as geologic, climatic, edaphic and biotic including man's activities. The major contributions from Humboldt to the present time. Mr. Hodgdon. 3 cr. (Alternate years; not offered in 1963-64.)

103. ADVANCED PLANT PATHOLOGY. Advanced theories and methods in plant pathology. Mr. Rich. *Prereq.*: Botany 51. Assigned reading, conferences and laboratory. 3 cr. (Alternate years; offered in 1963-64.)

105. ADVANCED PLANT PHYSIOLOGY. An intensive study of plant physiological phenomena, such as absorption, permeability, mineral nutrition, photosynthesis and light effects, respiration, growth regulator effects. Mr. Dunn. *Prereq.*: Botany 56 or equivalent, or adequate preparation in the physical sciences. Conferences, laboratory, and assigned reading. 4 cr. (Alternate years; offered in 1963-64.)

107, 108. INVESTIGATIONS IN (a) SYSTEMATIC BOTANY, (b) PLANT PHYSIOLOGY, (c) PLANT PATHOLOGY, (d) PLANT ANATOMY AND MORPHOLOGY, (e) PLANT ECOLOGY, (f) MYCOLOGY, and (g) CYTOLOGY. Elective only upon consultation with the Chairman of the Department. Mr. Hodgdon, Mr. Dunn, Mr. Rich, Miss Nast, Mr. Richards, Mr. Schreiber. Hours to be arranged. 2 to 6 credits.

M.S. THESIS. 6-10 cr.

DOCTORAL DISSERTATION.

CHEMICAL ENGINEERING

OSWALD T. ZIMMERMAN, *Chairman*

To be admitted to graduate study in Chemical Engineering an applicant shall be expected to have completed a course of study substantially equivalent to that required for the degree of Bachelor of Science in Chemical Engineering in this University. However, students with good undergraduate records but with deficiencies in certain areas may be admitted on condition that they complete specified courses without credit to make up for their deficiencies.

A candidate for the Master's degree in Chemical Engineering must complete a thesis, for which up to 6 credits will be allowed, and he must pass an oral examination covering his thesis and graduate courses.

51. CHEMICAL ENGINEERING PRINCIPLES II. Transport phenomenon and stage operations. The equations of change as a basis for the study of molecular and turbulent transport of momentum, energy and mass, with emphasis upon the relation between the transport mechanism and the mathematical expression. Design principles and procedures for stagewise operations in various co-current and counter-current arrangements, based upon the ideal stage concept. Problems in both steady state and non-steady state operations. Mr. Lavine. 3 lec.; 1 lab.; 4 cr.

52. CHEMICAL ENGINEERING PRINCIPLES III. Analysis of unit operations. Study of chemical engineering systems, with emphasis on the unit operations involved. Extension of previous studies of unit operations, and those not previously considered. Mr. Zimmerman. 3 lec.; 1 lab.; 4 cr.

54. **CHEMICAL ENGINEERING PRINCIPLES IV.** Chemical kinetics, catalysis, and introduction to reactor design. Study of types of kinetic behavior in chemical processes; prediction of reaction rates in batch and flow reactors with and without catalysis; and application to reactor design. Mr. Fan. 3 lec.; 1 lab.; 4 cr.

63. **CHEMICAL ENGINEERING PRINCIPLES V.** Special methods of mathematical analysis including transform methods, calculus of finite differences, and numerical techniques; and the use of analog and digital computers in the solution of chemical engineering problems. Mr. Fan. 3 lec.; 1 lab.; 4 cr.

66. **CHEMICAL ENGINEERING ECONOMICS AND PLANT DESIGN.** The principles of cost engineering, including estimation of plant investment, working capital, operating costs, labor requirements, payout time, and profitability. Subject matter covered includes value of money, capitalized costs, simple and compound interest, depreciation, taxes and insurance, labor requirements, overhead, financing of chemical enterprises, design of equipment and plants for minimum cost, plant location, transportation, sales cost, equipment cost, and cost indexes. Each class selects one or more problems involving the complete design of a chemical plant. For each problem, the most desirable process must be determined, the site selected, the equipment and plant designed, calculations made for all costs, profitability and payout time, and a complete report prepared, including the drawings of equipment and plant layout. Mr. Lavine. 1 lec. or rec.; 3 lab.; 4 cr.

67. **CHEMICAL ENGINEERING THERMODYNAMICS.** General thermodynamic relationships and their application to power generation, refrigeration, and chemical processes; chemical equilibria and equilibrium in phase-change separations; introduction to statistical mechanics, and thermodynamics of irreversible processes. Mr. Fan. 3 lec.; 3 cr.

68. **PHYSICAL METALLURGY.** An introductory study of the nature of metals, emphasizing the quantum mechanical description of the solid state and including atomic structure, bonding, historical development of metal theories, elementary zone or band theory, and X-ray diffraction. The microscopic metal system is also considered, and thermodynamics of metallurgical processes, defects and dislocations, phase relations of pure metals and alloys, microstructure, and physical and thermal treatment of metals are discussed. Study of some non-metals is also included. Mr. Zimmerman. 3 lec.; 1 lab.; 4 cr.

69. **CHEMICAL ENGINEERING PROJECT.** Each student selects a research problem which he carries out independently under faculty supervision. Intensive study in both the library and the laboratory and a satisfactory report upon completion of the work are required. Ch. E. Staff. 3 lab.; 3 cr.

81. **PROCESS DYNAMICS.** Responses of physical systems and feedback principles and their application to design and analysis of process control systems. Mr. Zimmerman. 3 lec.; 3 cr.

110-111. **GRADUATE SEMINAR.** Discussions by staff and graduate students on recent developments in chemical engineering. 1 lab.; 1 cr.

125. **HIGH POLYMERS.** Principles and practice of high polymer manufacture including industrial polymerization methods and equipment design. Laboratory work includes a study of typical polymerization reactions and the physical and chemical testing of various types of plastics and synthetic fibers. Mr. Lavine. 2 lec.; 1 lab.; 3 cr.

127. **CHEMICAL ENGINEERING CALCULATIONS.** Mathematical procedures, stressing application to the analysis of chemical engineering data and limitations of these procedures. Included are differential equations, statistics, series and numerical solutions, Laplace transforms, and the analysis of stage-wise processes by the calculus of finite differences. Mr. Fan. 3 lec.; 3 cr.

128. **CHEMICAL ENGINEERING KINETICS.** Theory of reaction rates, batch and flow reactors, and catalytic reactions. Application of kinetics in industrial situations is stressed. Partial differential equations for heat and mass transfer in a reactor and their solutions for determining temperature and concentration distributions are emphasized. Mr. Fan. 3 lec.; 3 cr.

129. **TRANSPORT THEORY.** Correlations of chemical engineering data from the point of view of their theoretical justification, and the mathematical treatment of transport phenomena applied to heat, mass, and momentum transport. Mr. Fan. 3 lec.; 3 cr.

135. **UNIT OPERATIONS—FLUID FLOW, HEAT FLOW, AND EVAPORATION.** An advanced course dealing with the fundamental theory and applications of these operations. Mr. Zimmerman. 2 lec. or rec.; 2 cr.

136. **UNIT OPERATIONS—DIFFUSION OPERATIONS.** An advanced study of the principles of diffusion and their application to the unit operations of distillation, absorption, drying, humidification, and extraction. Mr. Zimmerman. 2 lec. or rec.; 2 cr.

137, 138. **UNIT PROCESSES.** A study of the more recent developments in pyrolysis, oxidation, chlorination, nitration, polymerization, and other unit processes. Mr. Lavine. 2 lec.; 2 cr.

139. **CHEMICAL ENGINEERING THERMODYNAMICS.** A study of recent developments in thermodynamics with particular emphasis on low temperature and high-pressure processes. Mr. Zimmerman. 2 lec.; 1 rec.; 3 cr.

141, 142. **THESIS—PROBLEMS IN CHEMICAL ENGINEERING.** Independent investigations in some phase of chemical engineering. Ch. E. Staff. Credits to be arranged.

151. **INTRODUCTION TO NUCLEAR ENGINEERING.** The scientific and engineering development of nuclear reactors is treated, including basic binding energy physics, nuclear stability, radioactivity, the elements of nuclear reactor theory, and the engineering problems of heat transfer, fluid flow, materials selection, and shielding. This course is intended for any interested graduate students. Mr. Zimmerman. 3 lec.; 3 cr.

152. **NUCLEAR CHEMICAL TECHNOLOGY.** The design, construction, and operation of nuclear process equipment, including reactors and associated chemical processing facilities, and isotope separations plants. The technology of applied radiation chemistry is also treated. Intended primarily for graduate students in Chemical Engineering. Mr. Zimmerman. 3 lec.; 3 cr.

CHEMISTRY

ALEXANDER R. AMELL, *Chairman*

Admission to graduate study for the M.S. and Ph.D. degrees in Chemistry is based upon the general cumulative undergraduate average of 2.5 and requires the usual undergraduate courses

in general chemistry, analytical chemistry, organic chemistry, and physical chemistry with the supporting courses in mathematics and physics.

Entering graduate students are expected to take proficiency tests in chemistry to assist in starting the new student's graduate work at the proper level. These examinations will be offered at the beginning of the fall semester in September and in February. Normally the residence requirements will consist of one academic year for the M.S. degree and a total of three academic years for the Ph.D. degree. Both degrees require the completion of a research problem which is described in a written thesis. The final examination for both M.S. and Ph.D. degrees is an oral defense of the thesis.

The Ph.D. candidate will be expected to demonstrate proficiency in reading chemical literature in German and French or Russian. He will also demonstrate to the Doctoral Committee that he has a broad basic knowledge of the field of chemistry 1) by taking certain fundamental graduate courses and 2) by means of a series of examinations in his major field. The principal emphasis of the last two years will be on a research project which will constitute the dissertation. During this time the doctoral candidate will present and defend two original research proposals before his Doctoral Committee.

In addition to the above degrees, a special degree of Master of Science for teachers is offered for candidates who hold a secondary school teacher certification in Chemistry. Courses leading to this degree will normally be chosen from Summer Session and National Science Foundation summer institute offerings and require thirty semester hours in courses approved by the Chairman of the Department.

Inorganic Chemistry

85. INORGANIC CHEMISTRY. The relationship between chemical reactions and modern concepts of inorganic chemistry on a moderate level. The applicability and limitations of the newer ideas. Mr. Haendler. *Prereq.*: Chem. 83-84, or permission. 3 lec.; 3 cr.

104. ADVANCED INORGANIC CHEMISTRY. A survey of inorganic chemistry from the modern point of view, with emphasis on theoretical and structural concepts. Mr. Haendler. *Prereq.*: Chem. 85, or its equivalent. 3 lec.; 3 cr.

107. ADVANCED INORGANIC CHEMISTRY. The chemistry of coordination compounds, their structure, stereochemistry, and reactions. The metal-ligand bond. Mr. Haendler. *Prereq.*: Chem. 104. 3 lec.; 3 cr.

132a. ADVANCED INORGANIC CHEMISTRY. A course on the theory and practice of x-ray diffraction and the determination of crystal structure. Mr. Haendler. *Prereq.*: Chem. 104. 3 lec.; 3 cr.

Analytical Chemistry

61-62. **ANALYTICAL CHEMISTRY.** A thorough treatment of the theory and techniques of gravimetric and volumetric analysis followed by special methods of analysis such as those of ion exchange, chromatography, EDTA titrations and instrumental methods, such as emission spectrography, flame spectrometry, spectrophotometry, gas chromatography, coulometry, potentiometry, conductimetry, and polarography. Mr. Daggett. *Prereq.:* Chem. 5, 6. 3 lec.; 2 lab.; 5 cr.

63. **INTRODUCTORY RADIOCHEMICAL TECHNIQUES.** A discussion of radiochemical techniques and laboratory practice in the use of apparatus in many fields of science which utilizes radiochemical operations. *Prereq.:* General Inorganic Chemistry and General Physics. Mr. Amell. 3 lec.; 2 lab.; 5 cr.

130. **ADVANCED ANALYTICAL CHEMISTRY.** This course will consider first a comprehensive review of the basic principles of qualitative and quantitative analysis, including stoichiometric calculations. More advanced methods will then be considered from the standpoints of basic principles and applications. Included will be such subjects as polarography, potentiometric titrations, titrations in nonaqueous solvents, chromatography, thermogravimetric analysis, applications to radioactive tracers, spectrophotometry, mass spectrometry, etc. Mr. Daggett. 3 lec.; 3 cr.

Organic Chemistry

55-56. **STRUCTURAL AND THEORETICAL PROBLEMS OF MODERN ORGANIC CHEMISTRY.** An intensive study of the methods of preparation and reactions of the principal classes of organic compounds. The electron theory of organic chemistry is used to correlate these reactions. The variation in reactivity of these various classes of organic compounds is utilized as a method of characterization of organic compounds. Emphasis is on the solution of assigned problems. Mr. Lyle. *Prereq.:* One year of organic chemistry. First semester, 1 lec.; 2 lab.; 3 cr. Second semester, 3 lec.; 3 cr.

101, 102. **ADVANCED ORGANIC CHEMISTRY.** A study of the reactions of the more important functional groups. Current electronic and structural theories are used in correlating facts wherever possible. Mr. Kuivila. *Prereq.:* A year's course in organic chemistry. 3 lec.; 3 cr.

111. **ORGANIC CHEMISTRY.** The chemical and physical properties of heterocyclic compounds, and the relationship of these properties with the molecular structure of the heterocycle. Mr. Lyle. 3 lec.; 3 cr.

112. **ORGANIC CHEMISTRY.** A study of physical and chemical methods for determining the structures of representative alkaloids and steroids. The chemical and biochemical syntheses of alkaloids and steroids will be considered. Mr. Lyle. 3 lec.; 3 cr.

115. **MODERN LABORATORY TECHNIQUES IN ORGANIC CHEMISTRY.** A course to acquaint the graduate student with the principles and practice of the more recent laboratory methods. Techniques such as fractional distillation, chromatography, catalytic hydrogenation, and ultraviolet and infrared spectroscopy are discussed and employed. Mr. Jones. 2 lec.; 1 lab.; 3 cr.

116. ORGANIC QUALITATIVE ANALYSIS. The reactions and properties of organic compounds. Use of group reactions in the identification of organic substances. Mr. Lyle. 1 lec.; 2 to 4 lab.; 3 to 5 cr.

117. STEREOCHEMISTRY. A discussion of the structural theory of organic chemistry in its broader aspects. Besides optical and geometrical isomerism other topics such as steric hindrance, strain theory, and conformational analysis are considered. Mr. Kuivila. *Prereq.*: Structural and Theoretical Problems of Modern Organic Chemistry or equivalent. 3 lec.; 3 cr.

118. REACTION MECHANISMS. Study of the theoretical and experimental tools used in the study of organic reaction mechanisms and application of these to reactions such as the displacement reaction, eliminations, additions to the double bond, carbonyl and carboxyl reactions, and aromatic substitutions. Mr. Kuivila. *Prereq.*: Stereochemistry is recommended but not required. 3 lec.; 3 cr.

Physical Chemistry

83-84. ELEMENTARY PHYSICAL CHEMISTRY. The properties of gases, liquids, and solids; thermochemistry and thermodynamics; solutions, chemical equilibria, reaction rates, conductance and electromotive force. Mr. Wheeler. *Prereq.*: Quantitative Analysis, Calculus, Physics. 3 lec.; 2 lab.; 5 cr. (Cannot be taken for credit by graduate students in Chemistry.)

86. ADVANCED PHYSICAL CHEMISTRY. A review of selected topics in elementary physical chemistry. Mr. Amell. *Prereq.*: One year of Physical Chemistry. 3 lec.; 3 cr.

105, 106. ADVANCED PHYSICAL CHEMISTRY. An introduction to wave mechanics and quantum chemistry, spectroscopy, molecular structure; second and third laws of thermodynamics, statistical thermodynamics, kinetics and mechanism. Mr. Pilar or Mr. Amell. *Prereq.*: One year of Physical Chemistry. 3 lec.; 3 cr.

121. PHYSICAL CHEMISTRY — CHEMICAL KINETICS. A study of the kinetics of homogeneous and heterogeneous reactions in gaseous and liquid systems, including an introduction to photochemistry. Mr. Amell. *Prereq.*: One year of Physical Chemistry. 3 lec.; 3 cr.

122. PHYSICAL CHEMISTRY — CHEMICAL THERMODYNAMICS. A study of the foundations and inter-relationships of the theory of thermodynamics. The methods by which the theoretical principles may be applied to practical problems are discussed and applied. Mr. Wheeler. *Prereq.*: Chem. 105. 3 lec.; 3 cr.

124. ADVANCED PHYSICAL CHEMISTRY LABORATORY. The more modern experimental technique of physical chemistry. Emphasis on the needs and interests of each individual student. Topics will include the measurement of refractive index, molecular rotation, activity coefficients by vapor pressure and E.M.F. methods, heterogeneous and homogeneous equilibrium constants, and kinetic constants. Mr. Wheeler. 1 lec.; 2 lab.; 3 cr.

126. NUCLEAR AND RADIOCHEMISTRY. A detailed study of nuclear structure and reactions, particle accelerators, radioactive decay, detection of particles, and the interaction of particles with matter. Application of radiochemistry to chemical systems and research. Mr. Amell. 3 lec.; 3 cr.

127, 128. **THEORETICAL CHEMISTRY.** Fundamental principles of quantum mechanics; approximate quantum mechanical treatments of chemical bond problems; derivation of various types of partition functions and applications to chemical thermodynamics and intermolecular forces; application of Maxwell-Boltzmann distribution law; elements of Fermi-Dirac and Bose-Einstein statistics. Mr. Pilar. *Prereq.*: 105-106. 3 lec.; 3 cr.

131-132. **COLLOQUIUM IN CHEMISTRY.**

- a. Inorganic Chemistry, Mr. Haendler
- b. Organic Chemistry, Mr. Anderson
- c. Organic Chemistry, Mr. Lyle
- d. Theoretical Organic Chemistry, Mr. Kuivila
- e. Organic Chemistry, Mr. Iddles
- f. Physical Chemistry, Mr. Amell
- g. Physical Chemistry, Mr. Pilar
- h. Physical Chemistry, Mr. Wheeler
- i. Analytical and Physical Chemistry, Mr. Daggett
- j. Organic Chemistry, Mr. Jones
- k. Organic Chemistry, Mrs. Lyle
- l. Analytical Chemistry, Mr. Ellis

3 lec.; 3 cr. Sections of the course may be taken to a total of 12 cr.

141-142. **SEMINAR.** Presentation and discussion of recent investigations in the field of chemistry. 1 cr.

151, 152. **THESIS PROBLEMS IN CHEMISTRY.** Conferences, library, and experimental work in some field of chemistry. Analytical Chemistry and Physical Chemistry, Mr. Daggett; Inorganic Chemistry, Mr. Haendler; Organic Chemistry, Mr. Iddles, Mr. Kuivila, Mr. Lyle, Mr. Jones, Mrs. Lyle, Mr. Andersen, and Mr. Sawyer. Physical Chemistry, Mr. Amell, Mr. Pilar, and Mr. Wheeler. *Prereq.*: Special permission. Credits to be arranged.

National Science Foundation Summer Institute Courses

91. **THE TEACHING OF HIGH SCHOOL CHEMISTRY.** A presentation of the present day subject matter in general chemistry; a discussion of the choice of experiments for the laboratory and for lecture demonstrations; and presentation and evaluation of teaching methods which are effective in stimulating students in chemistry. 4 cr.

92. **MODERN INORGANIC CHEMISTRY FOR THE HIGH SCHOOL TEACHER.** A presentation of the current concepts on such topics as fundamental particles, atomic structure, nuclear reactions, electronic configurations and orbitals, chemical bonds, the periodic table, oxidation-reduction, acids and bases, energy relationships, and ionic reactions. *Prereq.*: Freshman chemistry. 4 cr.

93. **ANALYTICAL CHEMISTRY FOR HIGH SCHOOL TEACHERS.** The principles of ionic equilibria as they apply to qualitative and quantitative analysis. The experimental work in qualitative analysis is presented using the semimicro technique. The experimental work in quantitative analysis is designed to acquaint the student with the principles, techniques, and calculations of gravimetric and volumetric determinations. Some experimental work is included involving the use of the spectrophotometer in quantitative analysis and the glass electrode method of measurement of pH. 8 cr.

94. MODERN APPROACH TO ORGANIC CHEMISTRY FOR HIGH SCHOOL TEACHERS. A thorough survey of the structure and properties of organic compounds, including those of current interest and importance such as natural and synthetic polymers, antibiotics and medicinals. An understanding of the behavior of organic compounds will be based on current theories of reactions. *Prereq.*: General chemistry. 8 cr.

95. PHYSICAL CHEMISTRY FOR HIGH SCHOOL TEACHERS. A discussion of the laws of chemistry and their application to physical and chemical changes. *Prereq.*: College physics and college algebra and trigonometry. 8 cr.

96. RADIOCHEMISTRY FOR HIGH SCHOOL TEACHERS. A discussion of the theory of radioactive decay, the effects of radioactive decay upon matter, and the methods and techniques of the detection of radioactive decay. The uses of radiotracers in research will be discussed. *Prereq.*: General chemistry and general physics. 4 cr.

97. LABORATORY TECHNIQUES IN CHEMISTRY. A presentation of modern laboratory techniques for the separation, identification, and estimation of substances. Experiments will be designed to assist the teacher by providing new subjects for laboratory demonstrations and student projects. *Prereq.*: Analytical and organic chemistry. 4 cr.

98. ADVANCED ORGANIC CHEMISTRY FOR HIGH SCHOOL TEACHERS. A presentation of types of homolytic and heterolytic reactions of organic compounds and their relationship to organic structures, including configuration and conformation. *Prereq.*: Chem. 94 or its equivalent. 4 cr.

99. ATOMIC AND MOLECULAR STRUCTURE. A discussion of the methods of determining atomic and molecular structure, including ultraviolet and infrared spectroscopy and radiochemistry. 4 cr.

CIVIL ENGINEERING

J. HAROLD ZOLLER, *Chairman*

A candidate for the degree of Master of Science in Civil Engineering must have completed a course of study equivalent to that required by this department for the baccalaureate degree or he must take specified courses in the areas of deficiency without credit. An oral final examination is required of all candidates.

A candidate for the Master's degree will normally complete a thesis for not less than 6 nor more than 9 hours of credit. With the permission of the department, a student may be permitted to substitute approved course work for the thesis requirement. In this event he must also submit to his examining committee a paper written in one of his courses, which shall be the equivalent of a thesis in style and quality, but not in scope. One copy of the thesis or paper is required by the department.

Courses numbered above 70 may be offered biennially or upon demand.

50. **TRANSPORTATION ENGINEERING.** The development, organization, administration, and inter-relation of transportation systems and facilities, including railroads, highways, airports, waterways, and pipe lines. Major emphasis will be given to the economics of location, geometric and structural design, construction materials, methods, and costs, as applied to modern transportation engineering. Mr. Skelton. *Prereq.:* C.E. 2. 3 lec.; 3 cr.

52. **FLUID MECHANICS.** Properties of fluids; fluid statics; flow of incompressible and compressible ideal fluids; flow of real fluids; and measurement of fluid properties. Mr. Dawson and Mr. Zoller. *Prereq.:* M. E. 35. 3 lec.; 3 cr.

53. **FLUID MECHANICS LAB.** Experimental study of fluid properties and their relation to the solution of practical problems. Mr. Dawson. *Prereq.:* C. E. 52 as a prerequisite or concurrently. 1 lab.; 1 cr.

54. **SOIL MECHANICS.** Soil classification, physical properties including permeability, compressibility, bearing capacity, settlement, and shear resistance are related to the principles underlying the behavior of soils subjected to various loading conditions. Underground exploration and typical foundation problems are included. Mr. Skelton. *Prereq.:* C. E. 50 or permission of the instructor. 3 lec.; 1 lab.; 4 cr.

56. **STEEL DESIGN.** The design of members and connections; tension and compression members, beams, plate girders; riveted, bolted, and welded joints. Mr. Wang. *Prereq.:* C. E. 17 and 25. 2 lec.; 1 design period; 3 cr.

57. **THEORY OF STRUCTURES II.** Beam and truss deflections. The analysis of continuous beams and rigid frames by classical and modern methods; indeterminate trusses. Mr. Wang. *Prereq.:* C. E. 56. 3 lec.; 1 design period; 4 cr.

59. **REINFORCED CONCRETE DESIGN.** The principles of reinforced concrete, including rectangular beams, slabs, T-beams, columns, footings, retaining walls. Mr. Wang. *Prereq.:* C. E. 57 as a prerequisite or concurrently. 2 lec.; 1 design period; 3 cr.

60. **STRUCTURAL ENGINEERING.** The planning and design of determinate and indeterminate structures. Introduction to modern design theories; prestressed concrete, plastic theory of steel and reinforced concrete. Mr. Wang. *Prereq.:* C. E. 57 and C. E. 59. 2 lec.; 1 design period; 3 cr.

63. **WATER SUPPLY AND TREATMENT.** The sources, quantity, quality, and sanitary aspects of public water supplies. Methods of purification and distribution systems. Mr. Langley. *Prereq.:* C. E. 51. 3 lec.; 3 cr.

64. **SEWERAGE AND SEWAGE TREATMENT.** The theory and problems of sewerage, the principles governing the disposal of sewage, and the various methods of sewage treatment. Mr. Langley. *Prereq.:* C. E. 63. 3 lec.; 1 lab.; 4 cr.

65. **HYDRAULIC ENGINEERING.** Application of fluid mechanics to hydraulics problems, such as reservoirs, dams, control works, open-channel flow, hydroelectric power, irrigation, drainage, and multi-purpose projects. Mr. Langley and Mr. Zoller. *Prereq.:* C. E. 52. 2 lec.; 1 lab.; 3 cr.

66. **HYDROLOGY.** The occurrence and physical effects of water on the earth, including meteorology, groundwater, runoff, and streamflow routing. Mr. Langley and Mr. Zoller. *Prereq.:* C. E. 52 concurrently or as a prerequisite. 2 lec.; 1 lab.; 3 cr.

67. **HIGHWAY ENGINEERING I.** Highway organization, administration, finance, planning, programming, traffic surveys, traffic methods; highway laws, contracts, specifications; highway capacity, geometric design, access control, safety, accident studies; pavement selection, performance, and maintenance. Mr. Skelton. *Prereq.*: C. E. 50. 3 les.; 3 cr.

68. **HIGHWAY ENGINEERING II.** Design of flexible and rigid pavements and bases for highways, airports, and city streets; pavement selection, construction methods, materials, specifications, and engineering cost estimates. Mr. Skelton. *Prereq.*: C. E. 50. 3 lec.; 1 lab.; 4 cr.

71. **COMMUNITY PLANNING.** An introduction to the subject of community planning. Social, economic, and physical factors affecting community planning; content and extent of desirable community planning programs, including purpose and scope, the preliminary survey, elements of community land planning, the master plan, transportation systems, street patterns and traffic, motor vehicle parking, airport sites, public building sites, parks and recreational facilities, zoning, control of land sub-division, neighborhood centers, housing, legal, financial and economic problems, and redevelopment of blighted areas. Mr. Dawson. *Prereq.*: Permission of the instructor. 3 lec.; 3 cr.

74. **TIMBER DESIGN.** Properties and characteristics of structural woods, connection methods, design of timber members and connections in beams, columns, and trusses, and glued laminates of wood. Mr. Wang. *Prereq.*: C. E. 25 and C. E. 56 and permission of the instructor. 1 lec.; 1 design period; 2 cr.

77. **CONTRACTS, SPECIFICATIONS, AND PROFESSIONAL RELATIONS.** A study of the essential elements required in engineering contracts; the purposes and content of specifications; professional conduct, relations, and ethics; and estimating by means of quantity surveys and unit cost methods. Mr. Dawson. *Prereq.*: Permission of the instructor. 3 lec.; 3 cr.

78, 79. **STRUCTURAL COMPONENTS.** Selected problems in the analysis and design of structural components, such as beams on elastic foundations, curved beams, beam columns, buckling, torsion. Introduction to the theory of elasticity. Mr. Wang. *Prereq.*: C. E. 56 and permission of the instructor. 3 lec.; 3 cr.

101, 102. **CIVIL ENGINEERING PROBLEMS.** A special course designed to make possible the study and investigations of problems of Civil Engineering selected to meet the needs of the student. *Prereq.*: Permission of the instructor. 2 or 3 cr.

103-104. **SOIL MECHANICS.** The physical and mechanical properties of soil in relation to engineering structures. The theory of consolidation, shearing resistance, bearing capacity, settlement, earth pressure, and seepage studies. Mr. Skelton. *Prereq.*: C. E. 54 and permission of the instructor. 3 cr.

105. **SOIL TESTING FOR ENGINEERING PURPOSES.** Arranged to cover the essential soil tests for engineering purposes. Tests for the physical properties include: permeability, capillarity, compressibility, rate and magnitude of consolidation, and shearing resistance. Mr. Skelton. *Prereq.*: Permission of the instructor. 2 to 4 cr.

106. **FOUNDATION ENGINEERING.** Application of the principles of soil mechanics to selection of type of substructure, foundation construction methods, exploratory soil studies, stability analysis, earth dam and tunnel con-

struction, and underpinning operations. Mr. Skelton. *Prereq.*: C. E. 54 and permission of the instructor. 3 cr.

111-112. **ADVANCED HYDRAULICS.** Sediment transportation, secondary flows, design of hydraulic structures, reservoir and channel routing techniques, basic hydrodynamics and independent study. Mr. Zoller and Mr. Langley. *Prereq.*: Permission of the instructor. 3 cr.

113-114. **EXPERIMENTAL HYDRAULICS.** Experimental techniques and laboratory practice. Experimental studies of the fundamental phenomena of liquid flow. Mr. Dawon. *Prereq.*: C. E. 52 and permission of the instructor. 3 cr.

115-116. **ADVANCED HYDRAULIC AND SANITARY ENGINEERING.** Hydrology, hydraulics of river flow, flood flows, design of reservoirs, flood control, river control, and hydraulic and sanitary structures. Water treatment and sewage treatment practices. Mr. Zoller and Mr. Langley. *Prereq.*: C. E. 63 and 64 and permission of the instructor. 3 cr.

121-122. **ADVANCED STRUCTURAL ANALYSIS.** Comprehensive consideration of the methods of structural analysis and their application to the design of two and three-dimensional structures. Mr. Wang. *Prereq.*: C. E. 60 and permission of the instructor. 3 cr.

123. **ADVANCED STRUCTURAL DESIGN.** Ultimate strength design in reinforced concrete. Prestressed concrete design. Plastic design of steel structures. Mr. Wang. *Prereq.*: C. E. 57 and permission of the instructor. 3 cr.

129-130. **THESIS.** Hours and credits, from 6 to 9, are to be arranged.

DAIRY SCIENCE

HILTON BOYNTON, *Acting Chairman*

Students admitted to graduate study in Dairy Science are expected to have had satisfactory undergraduate preparation in Dairy Science, Animal Science, or other biological sciences.

Candidates majoring in Dairy Science will be required to pass an oral examination and prepare a thesis.

60. **DAIRY SEMINAR.** Recent agricultural experiment station and other literature covering the field of dairy production. Practice in looking up literature and in the preparation of oral and written reports. Staff. 2 lec.; 2 cr.

61. **A REVIEW OF DAIRY SCIENCE.** Subject matter covering the principles and practices relating to the latest information on dairy cattle breeding, feeding and management, and the processing and marketing of milk and its products. For teachers of Vocational Agriculture and other students with the permission of their advisers. Staff. Summer Session only. Two hours daily lec. and lab.; 2 cr.

62. **ADVANCED DAIRY SCIENCE.** Basic data, fundamental observations, and discussions of research contributing to the present status of the dairy industry. Mr. Moore. *Prereq.*: Adequate preparation in chemistry and bacteriology. 2 lec.; 2 cr.

63. **DAIRY CATTLE.** Purebred dairy cattle; breed history, pedigrees; family lines and methods of outstanding breeders; the application of the principles of genetics to the improvement of dairy cattle herd analysis. Mr. Morrow. 3 lec.; 1 lab.; 3 cr.

64. **MILK PRODUCTION.** Feeding and management of dairy animals, calf feeding, raising young stock, and feeding for economical milk production. Mr. Boynton. 2 lec.; 1 lab.; 3 cr.

65. **MARKET MILK.** The producing, handling, and distributing of market and certified milk, dairy farm inspection, and control of milk supply. Mr. Moore. 2 lec.; 1 lab.; 3 cr.

66. **ICE CREAM, BUTTER, AND CHEESE.** The making, handling, and marketing of ice cream, butter, and cheese. Mr. Moore. 2 lec.; 1 lab.; 3 cr.

101. **ANIMAL NUTRITION.** Incidental lectures, assigned reading and laboratory practice in methods of research with major emphasis on protein and energy metabolism. Mr. Colovos. *Prereq.:* A major in Animal Science or Dairy Science or equivalent. 3 cr.

102, (102). **ADVANCED DAIRY CATTLE.** Special emphasis will be given to the analysis and formulating of breeding programs and to milk secretion and factors influencing the quantity and quality of milk. Mr. Morrow. *Prereq.:* A major in Animal Science or Dairy Science, or equivalent. 2 lec.; 1 lab.; 3 cr.

107. **TECHNICAL CONTROL.** Chemical and bacteriological laboratory methods used in the technical control of milk and milk products. Mr. Moore. *Prereq.:* Dairy Bacteriology. 2 lec.; 1 lab.; 3 cr.

109, 110. **SPECIAL PROBLEMS IN DAIRY MANUFACTURE.** Detailed study of some special phase of dairy manufacturing. Mr. Moore. *Prereq.:* A major in Dairy Science. Conferences and special assignments. 3 cr.

111, (111). **SPECIAL PROBLEMS IN DAIRY PRODUCTION.** Study of some special phase of breeding or feeding as related to dairy-herd management. Mr. Morrow, Mr. Keener. *Prereq.:* A major in Dairy Science or Animal Science, or equivalent. Conferences and special assignments. 3 cr.

112, (112). **SPECIAL PROBLEMS IN ANIMAL NUTRITION.** Library work, conferences, and written reports on selected problems in animal nutrition. Mr. Keener. *Prereq.:* Adequate preparation in animal nutrition. 3 cr.

THESIS. Hours and credits, from 6 to 10, are to be arranged.

ECONOMICS

ROBERT F. BARLOW, *Dean*

Whittemore School of Business and Economics

Graduate work is offered in Economics leading to the Degree of Master of Arts.

Admission to graduate study in Economics is limited to students with a better than average undergraduate record. The prerequisite for graduate work consists of a minimum of 24 hours of undergraduate work in Economics and related fields of which at least 12 hours shall have been in Economics. The Economics requirement includes a year's work in Principles of Economics and one semester's work in Business and Economic Statistics. A student who has not completed the semester of

statistics may be admitted conditionally with the requirement that he pass (without credit) a one-semester course in Business and Economic Statistics given at the University of New Hampshire.

The candidate for a Master's degree must fulfill the general requirements of the Graduate School and the following departmental requirements: 18 semester hours in Economics in the Whittemore School in courses numbered above 100; a thesis, which may fulfill a maximum of six semester hours of the course requirements numbered above 100. The remaining twelve semester hours may be in Economics, in courses numbered above 50, or, with the consent of the major adviser, a maximum of nine semester hours will be accepted in courses numbered above 50 in related departments.

The thesis must be in form for presentation to the reading committee by May 1 of the year in which the degree is to be granted. No final examination is required.

51. **LABOR ECONOMICS.** Historical background and present status of labor organizations and problems. Labor-management relations and collective bargaining; economics of wages and employment; case studies. Mr. Hogan. *Prereq.:* Econ. 2. 3 lec. or rec.; 3 cr.

52. **PUBLIC FINANCE.** Problems and policies of expenditure, revenue and debt of federal, state, and local governments. Economic analysis and evaluation of individual types of taxes as well as entire government fiscal programs; critical appraisal of recommended changes in tax systems; tax problems in the State of New Hampshire. Mr. Rosen. *Prereq.:* Econ. 2. 3 lec. or rec.; 3 cr.

53. **MONEY AND BANKING.** The monetary and banking system with reference to monetary standards, value of money, commercial and non-commercial banking, and structure and policy of the Federal Reserve System. Mr. Degler. *Prereq.:* Econ. 2. 3 lec. or rec.; 3 cr.

54. **ADVANCED MONEY AND BANKING.** Advanced monetary theory and some of the more practical aspects of modern banking. Mr. Degler. *Prereq.:* A satisfactory average in Econ. 53. 3 lec. or rec.; 3 cr.

55. **GOVERNMENT REGULATION OF BUSINESS.** A study of the role of government in economic affairs, with emphasis upon the regulation of competition and monopoly. *Prereq.:* Econ. 2. 3 lec. or rec.; 3 cr.

63. **INTERNATIONAL TRADE AND FINANCE.** Theory of international trade, foreign exchange, balance of international payments, tariffs and protection; the economic aspects of international relations with particular reference to recent policies. Miss Woodruff. *Prereq.:* Econ. 2. 3 lec. or rec.; 3 cr.

64. **COMPARATIVE STUDY OF ECONOMIC SYSTEMS.** An examination of socialism, communism, capitalism, and modifications of these types, particularly as exemplified by leading nations. Miss Woodruff. *Prereq.:* Econ. 2 or permission of the instructor. 3 lec. or rec.; 3 cr.

66. **ECONOMIC DEVELOPMENT.** An analysis of the problems and available solutions confronting the so-called underdeveloped areas of the world. *Prereq.:* Econ. 2. 3 lec. or rec.; 3 cr.

73. **INTERMEDIATE ECONOMIC ANALYSIS.** Analysis of supply and demand. The determination of prices, production, and the distribution of income in realistic non-competitive situations as well as in the purely competitive model. General equilibrium. Mr. Bergeron. *Prereq.*: Econ. 2. 3 lec. or rec.; 3 cr.

74. **MATHEMATICAL ECONOMICS.** Application of quantitative techniques to problems in economic analysis. Mathematical models and econometric techniques. Mr. Bergeron. *Prereq.*: Permission of the instructor. 3 lec. or rec.; 3 cr.

75. **NATIONAL INCOME.** The measurement, theory, and public policy applications of national income. Mr. Rosen. *Prereq.*: Econ. 2. 3 lec. or rec.; 3 cr.

76. **ECONOMIC FLUCTUATIONS (Business Cycles)** Study of recurrent movements of prosperity and depression, with emphasis upon causes and public policy applications. Mr. Rosen. *Prereq.*: Econ. 2 and one additional semester course in Economics or permission of the instructor. 3 lec. or rec.; 3 cr.

77. **HISTORY OF ECONOMIC THOUGHT.** Traces the evolution of economic science. Examination and critical appraisal of the work of major economists and major schools of economics particularly with reference to the applicability of their theories to current economic problems and the extent to which their theories influence modern economics. Mr. Bergeron. *Prereq.*: Econ. 2. 3 lec. or rec.; 3 cr.

78. **CONTEMPORARY ECONOMIC THOUGHT.** A topical survey of post-Marshallian economics. *Prereq.*: Econ. 2. 3 lec. or rec.; 3 cr.

151, 152. **LABOR SEMINAR.** Advanced study of labor markets, wage incentive systems, job evaluation, relation of wage policy to employment and problems raised by these and other factors in negotiating collective bargaining contracts. Collective bargaining studied as a means of establishing a system of industrial jurisprudence. Class discussion based primarily on case studies. Mr. Hogan. 3 lec. or rec.; 3 cr.

157-158. **HISTORY OF ECONOMIC THOUGHT.** A critical study of the development of economic concepts and ideas. Attention is given to the various schools of economic thought. Mr. Bergeron. *Prereq.*: The consent of the instructor. 3 lec. or rec.; 3 cr.

181, 182. **READING AND RESEARCH IN ECONOMICS.** With the advice and consent of the instructor, a student prepared by training and experience to do independent work may register for a reading and research course. The student will undertake assigned problems and readings under the guidance of the instructor. Hours and credits by arrangement.

- A. Economic History, Miss Woodruff
- B. International Trade, Miss Woodruff
- C. Economic Theory, Mr. Bergeron
- D. Labor Economics, Mr. Hogan
- E. Public Finance, Mr. Rosen
- F. Money and Banking, Mr. Degler
- G. Corporations, Mr. Degler
- H. National Income, Mr. Rosen
- I. Economic Fluctuations (Business Cycles), Mr. Rosen

THESIS, 6 cr.

EDUCATION

EUGENE C. JORGENSEN, *Acting Chairman*

For admission to graduate study in Education, a student must present, in addition to a Bachelor's degree, evidence of having satisfactorily completed, for Curriculum I, either an undergraduate major in Elementary Education or (a) a year of Educational Psychology or its equivalent, and (b) major subject preparation comparable to University of New Hampshire undergraduate requirements.

For Curriculum II a student must be fully certified as a teacher or give other evidence of undergraduate preparation in psychology and the principles of education and have the personal qualifications necessary for counseling. Courses in human development and mental hygiene must be included.

Curriculum III is a program for teachers of the deaf operated in affiliation with the Crotched Mountain Foundation School for the Deaf. Students interested in entering this program will be expected to make their first contact with the Crotched Mountain Foundation School for the Deaf, Greenfield, N. H. The staff there will make a judgment as to the individual's suitability for teaching in this special field. If the candidate seems to have the personal qualifications for teaching the deaf, he then will apply to the Graduate School of the University for admission. This application will be acted upon by the Department of Education and the Dean of the Graduate School. The candidate will be required to meet in full the usual standards of admission for graduate study at the University. In addition to the general standards for admission for graduate study, students entering this program must meet certification requirements for teaching, preferably at the elementary level, and in addition to the usual work in psychology included in teacher-education programs should have a course in either abnormal psychology or mental hygiene. Also included in their training must be a course in teaching the language arts. The candidate must offer student-teaching and observation in public schools with normal children or at least one year of successful classroom teaching experience with normal children.

For the degree of Master of Education, 30 credits must be earned in Curricula I and II and 36 credits in Curriculum III. Areas in which competence must be demonstrated, and courses suggested to aid in acquiring this competence, are listed in Curriculum I, unless the student is preparing for guidance counseling in which case Curriculum II is the guide.

CURRICULUM I

1. PRINCIPLES OF EDUCATION.
Ed. 59
2. GENERAL METHODS AND CURRICULUM.
Ed. 58 or 160, or Ed. 89
3. SPECIAL METHODS.
Ed. 91 or 92, or Ed. 73 and 85
4. TEACHING EXPERIENCE.
Ed. 94 or successful teaching experience
5. DYNAMICS OF BEHAVIOR.
Psych. 89 or Psych. 141
6. ADVANCED EDUCATIONAL PSYCHOLOGY.
Ed. 150
7. MEASUREMENT.
Ed. 165
8. PHILOSOPHY OF EDUCATION.
Ed. 176

CURRICULUM II

This program, for the preparation of school guidance counselors, represents a cooperative effort on the parts of the departments of Education and of Psychology. The degree earned will be Master of Education.

Usual Program of Studies

* Psych.	54	— Psychopathology
* Psych.	63	— Differential Psychology
† Psych.	108	— Case Studies in Counselling
† Psych.	123	— Individual Testing
* Educ.	111	— Principles of Guidance
† Educ.	117	— Occupational Information
‡ Educ.	118	— Administration of Guidance
* Educ.	119	— Techniques of School Counselling
* Educ.	120	— Practicum
* Educ.	165	— Tests and Measurement

Other Recommended Courses

‡ Psych.	141	— Personality Dynamics
‡ Educ.	114	— Curriculum Seminar
‡ Educ.	150	— Advanced Educational Psychology
‡ Educ.	176	— Philosophy of Education

The usual program of studies will prepare an individual for a career as a school guidance counselor. It also will serve as the first year of graduate study for a person desiring to become a school psychologist. To meet the

* Competence required.

† May be waived in individual cases when student's objective warrants.

‡ Suggested elective.

needs of persons with differing objectives, some flexibility has been incorporated in the program.

CURRICULUM III

This program is designed for teachers of the deaf and is operated by the University of New Hampshire in affiliation with the Crotched Mountain Foundation School for the Deaf. The following courses must be completed for the Master of Education Degree.

Academic Year

1. Teacher Training at Crotched Mountain Foundation School for the Deaf.
2. Psychology and Education of Exceptional Children (Ed. 181).
3. Audiology (Ed. 175).
4. History, Education, and Guidance of the Deaf.
5. Anatomy and Physiology of the Auditory and Vocal Mechanisms (Ed. 172).
6. Methods:
 - Speech Reading to the Deaf (Ed. 173).
 - Language to the Deaf, Part I (Ed. 170).
 - Language to the Deaf, Part II (Ed. 171.)
 - Elementary School Subjects to the Deaf (Ed. 178).
 - Speech to the Deaf (Ed. 174).
 - Observation and Student Teaching (Ed. 177).
7. Advanced Audiology (Ed. 179).
8. Selection and Use of Hearing Aids (Ed. 180).

Summer Session

1. Mental Hygiene for Teachers (Psych. 89).
2. Advanced Educational Psychology (Ed. 150).
3. Educational Philosophy (Ed. 176).

Students who meet the requirements described are free to select, subject to the approval of an adviser, the remainder of their work required for the degree from Education and subject-matter courses arranged to secure most effective preparation for the professional work they desire to pursue. Students will be able to choose from a variety of courses designed to be helpful: to students who are interested in increasing their teaching efficiency in the elementary school and the junior high school, as well as in the senior high school; to teachers and administrative officers who are interested in physical education activities; and to educational administrators and teachers who are preparing to enter fields of administration or supervision.

FINAL EXAMINATION. Near the end of thirty semester hours of work the candidate for the Master's degree in Education in Curricula I or II begins writing, with the help of the Chairman of the Master of Education Degree Committee, a group of state-

ments which are his own stand on basic issues in education. The aim of the writing of these statements is to help the candidate pull together the ideas and points of view he has taken from course work and his previous experience into his own consistent and working philosophy of education. When he finishes his courses and the writing of the complete set of statements, he defends these statements in an oral examination. If the oral examination is to be taken during the academic year, completed theses must be submitted on or before April 20; if the examination is scheduled for the summer, July 20 is the last date for submitting the completed theses. No more than two opportunities are permitted for the submission of the complete sets of statements to the Master of Education Degree Committee, and no more than two opportunities are permitted for the oral examination. Students in Curriculum III are not required to write theses or take the oral examination.

53, (53). THE HISTORY OF EDUCATIONAL IDEAS. All of the modern theories, and practices and all of the present-day conflicts about education have their stems in the past. In this course some of the scholarship of the social sciences as well as the materials from the history of education will be related to contemporary educational viewpoints. A better understanding of the bases of American ideas about education should result from this approach. 3 cr. (*Offered in Extension and Summer Session only.*)

54, (54). EDUCATION IN FOREIGN COUNTRIES. In this course educational developments in selected foreign countries will be examined in relation to the cultural background and present-day needs of the people. Attention will be directed to the sociological and psychological factors that influence the educational policy and the structure of each national school system. 3 cr. (*Offered in Extension and Summer Session only.*)

55. AN EDUCATIONAL PSYCHOLOGY OF DEVELOPMENT. The relation of factors of growth, learning, intelligence, individual differences, and personality to more effective learning. Emphasizes child development. 3 cr.

57. PRINCIPLES OF LEARNING. Psychology of learning as it operates within the classroom. *Prereq.*: Education 41 or 55 and permission of the department. 3 rec.; 3 cr.

58, (58). PRINCIPLES OF TEACHING. Application of the theories of learning studied in Education 57, with specific emphasis upon the following: organization of content, specific planning, and a study of procedures essential to the evaluation of the learning processes. *Prereq.*: Education 57 and permission of department. Two 2-hour rec.-labs.; 3 cr.

59, (59). PRINCIPLES OF EDUCATION. American schools have developed, and are still developing, in unique forms quite unlike their European counterparts. Among Americans, however, there are basic disagreements concerning the direction our schools should take. This course deals with these conflicts of philosophy, the problems of American education, and research pertinent to these problems. 3 cr.

63. INSTRUCTIONAL MEDIA. To help improve ability to communicate ideas through materials and equipment commonly available in a school audio-

visual center. Educational films, bulletin board design, the role of language labs, educational television, programmed learning, and media research will receive particular attention. A laboratory period of one hour each week is required in addition to the regular class period. Mr. Bardwell. *Prereq.*: Ed. 57 or permission of instructor. 3 cr.

64. UTILIZATION OF TESTING IN PUBLIC EDUCATION. Strategies for discovering and employing predictive validities of standardized tests in public school work are studied and practiced. Mr. Lohnes. 3 cr.

95. PRINCIPLES OF ELEMENTARY EDUCATION. A study of the underlying principles of education as applied to the teaching of children in elementary schools will be coordinated with the fundamentals of educational psychology and translated in terms of methods of teaching. Adaptation of various methods and plans as carried on in modern elementary schools will be considered. Miss Stone. 3 cr.

99 a, b, e, g, l, m, p, s, u. SPECIAL METHODS IN SECONDARY SCHOOL TEACHING. These courses deal with the curricula and methods in the various secondary school subjects. Emphasis will be on observation and planning. There will be a different course for each major subject area:

- a - art
- b - biology
- e - English
- g - general science
- l - foreign language
- m - mathematics
- p - physical science
- s - social studies
- u - music

Prerequisites: Education 57 and 58 or 160. May be taken concurrently. Preparation in subject-matter field equivalent to a college major. 3 cr.

102. PUBLIC SCHOOL ADMINISTRATION. For students who have had teaching or administrative experience, and are looking forward to further work as superintendent, principal, or department head. Emphasis will be placed upon the following functions of public school administration: policy making, management, personnel, public relations, finances, housing, curricula, reporting, research. 3 cr.

111. PRINCIPLES OF GUIDANCE. A first course which tries to help the student understand and utilize the philosophies and processes of guidance as they operate in his own behavior. Mr. Menge. *Prereq.*: Educational Psychology. 3 cr.

113. PRINCIPLES AND PROBLEMS OF SECONDARY-SCHOOL CURRICULUM REORGANIZATION. The course will be concerned with significant changes in secondary-school offerings, with special emphasis upon curriculum revision and techniques of revision. Mr. Koch. 3 cr.

114. SEMINAR IN CURRICULUM STUDY. The techniques and procedures of curriculum development for the purpose of better meeting the educational needs of adolescents. Mr. Koch. 3 cr.

117. INFORMATIONAL MATERIALS IN GUIDANCE. A broad perspective of guidance materials, including follow-up studies, community surveys, and the *Dictionary of Occupational Titles*. Designed for teachers or prospective counselors working toward certification in guidance. *Prereq.*: Ed. 111 or permission of the instructor.

118. ORGANIZATION AND ADMINISTRATION OF GUIDANCE. An advanced course for teacher-counselors, counselors, and administrators who are interested in planning or reorganizing a guidance program. It will be conducted as a seminar, giving practice in group dynamics. *Prereq.*: Ed. 111, 117, 165, or permission of the instructor. 3 cr.

119. TECHNIQUES OF SCHOOL COUNSELING. Methods of counseling school pupils. Mr. McIntire. *Prereq.*: Ed. 111. 3 cr.

120. EXPERIENCE IN COUNSELING. Vocational and educational counseling of adolescents under supervision. *Prereq.*: Ed. 117, 165, and permission of the instructor. 1-4 cr.

122. PROBLEMS IN THE SUPERVISION OF TEACHING. Problems of human relations in curriculum development. Field research or library research is required. Designed for principals, superintendents, and the supervisors of cadet teachers. 3 cr.

125. EDUCATIONAL FINANCE AND BUSINESS MANAGEMENT. Aspects and principles of financing education, budgetary procedure, accounting, auditing, school indebtedness, financial reporting and business management comprise the units to be studied. Experience in handling practical school finance problems will be part of the project work. *Prereq.*: A basic administration course or equivalent in experience. 3 cr.

131-132. RESEARCH PROBLEMS IN EDUCATION. *Prereq.*: Permission of instructor. 2 to 6 cr.

133, 134. SEMINAR IN EDUCATIONAL ADMINISTRATION. The study of cases and concepts. *Prereq.*: A basic administration course. 3 cr.

150. ADVANCED EDUCATIONAL PSYCHOLOGY. Special topics in the field of educational psychology with emphasis upon the learning process: (a) examination of learning situations in the classroom in the light of experimental research; (b) examination and evaluation of learning situations in the light of the major theories of learning. Mr. Koch. *Prereq.*: Ed. 57. 3 cr.

160. ADVANCED STUDY IN PLANNING FOR TEACHING IN HIGH SCHOOL. An opportunity to study problems, principles, and teachings which are involved in planning for pupil learning in high school. *Prereq.*: For graduate students with teaching experience. 3 cr.

162. PROGRAMMED INSTRUCTION. Examination of the advantages and limitations of programmed instruction and of its psychological foundation. The various types of teaching machines will be considered. The results of experimentation with programmed instruction will be considered. The method of developing programmed instruction material will be studied and practiced. Mr. Bardwell. 3 cr.

165. EDUCATIONAL TESTS AND MEASUREMENTS. Testing theory and practice, concerned with a two-fold analysis of standardized tests and batteries, in terms of (a) their psychological, or factorial, meanings, and (b) their practical, or predictive uses. Mr. Lohnes. 3 cr

167-168. MULTIVARIATE STATISTICAL PROCEDURE. A study of selected multivariate statistical methods and their applications to behavioral research. The purpose of the course is to produce informed consumers of the analyses which are now available from computers and which form the basis of much of the literature of the behavioral sciences. The facilities of the UNH

Computation Center will be employed. *Prereq.*: preparation in elementary statistics (consult instructor). Mr. Lohnes. 3 cr.

169. HISTORY, EDUCATION, AND GUIDANCE OF THE DEAF. History of the education of the deaf and the evaluation of the place of the deaf in the community from social, economic, and political viewpoints from ancient times to present. Bibliographic source materials in the field on the education and welfare of the deaf. Studies related to the psychology of the deaf, social adjustment of the deaf, the learning problems of the deaf. Given at Crotched Mountain Foundation School for the Deaf. *Prereq.*: History or Philosophy of Education. 2 cr.

170-171. THE TEACHING OF LANGUAGE TO THE DEAF. I, II. A study of the principles and techniques of teaching language to the preschool and school-age deaf child. A study of the leading systems of teaching language to the deaf. Special emphasis on natural language for the deaf and the Fitzgerald Key. Given at Crotched Mountain Foundation School for the Deaf. *Prereq.*: Language Arts for Elementary School (or Methods of Teaching Language). 2 cr.

172. ANATOMY AND PHYSIOLOGY OF THE AUDITORY AND VOCAL MECHANISMS. Auditory and Speech Mechanisms. A study of the anatomy, physiology, and pathology of the speech and hearing mechanisms. Given at Crotched Mountain Foundation School for the Deaf. 2 cr.

173. METHODS OF TEACHING SPEECHREADING (Lip-Reading) TO THE DEAF AND HARD OF HEARING. The various principles and techniques of teaching speechreading, Nitchie, Jena, Kinzie, Muller-Walle, etc., and research pertaining to lipreading. Given at Crotched Mountain Foundation School for the Deaf. 2 cr.

174. THE TEACHING OF SPEECH TO THE DEAF. The principles and techniques used in developing the formation of English sounds by the analytical method and also the introduction of speech by the whole-word method. Correction of speech defects in the hard of hearing. Development of speech in the pre-school and school-age deaf child. Given at Crotched Mountain Foundation School for the Deaf. 2 cr.

175. AUDIOLOGY. Hearing tests and auditory training. The techniques and interpretation of pure tone hearing tests and an introduction to speech audiometry. Audiogram interpretation. Air and bone conduction tests on children of varying ages who are in schools for classes for the deaf. Introduction to several types of amplification systems used in school and classes for the deaf. Techniques and principles of auditory training programs in schools and classes for the deaf. Given at Crotched Mountain Foundation School for the Deaf. *Prereq.*: Anatomy and Physiology of Auditory Mechanisms. 3 cr.

176. PHILOSOPHY OF EDUCATION. A study of current educational objectives and practices and the philosophical foundations upon which they are based. Mr. Marshall. 3 cr.

177. OBSERVATION, STUDENT TEACHING, AND OTHER LABORATORY ACTIVITIES. Students travel widely to observe several schools having differing philosophies of education. Given at Crotched Mountain Foundation School for the Deaf. 3 cr.

178. METHODS OF TEACHING ELEMENTARY SCHOOL SUBJECTS TO THE DEAF. An understanding of what language deprivation means in developing ele-

mentary curriculum for the deaf child. Principles and methods of teaching reading to deaf children in the lower and higher grades. Methods of teaching subjects such as arithmetic, social studies, and sciences and health. Methodology in the intermediate and advanced grades. Consideration and use of visual aids in classes for the deaf. *Prereq.*: Methods in teaching elementary subjects, especially arithmetic, science, social studies, and reading or major in elementary or secondary education. Given at Crotched Mountain Foundation School for the Deaf. 2 cr.

179. **ADVANCED AUDIOLOGY.** Advanced puretone speech audiology. Special tests and exploratory techniques in audiometry, logical assessment, instrumentation and testing rooms. Industrial audiology and conduct of an audiological clinic. Given at Crotched Mountain Foundation School for the Deaf. *Prereq.*: Ed. 175. 3 cr.

180. **SELECTION AND USE OF HEARING AIDS.** The study of research and theory of clinical selection of hearing aids. Given at Crotched Mountain Foundation School for the Deaf. *Prereq.*: Ed. 172 & 175. 3 cr.

181. **PSYCHOLOGY AND EDUCATION OF EXCEPTIONAL CHILDREN.** A survey of all fields of special education. Psychological problems arising from handicapping conditions. Given at Crotched Mountain Foundation School for the Deaf. 2 cr.

Courses in Problems in Teaching High-School Subjects

The following courses are devoted to a study of problems of objectives, selection, and organization of subject matter, teaching and testing techniques and classroom management in the teaching of the respective subjects. To be admitted into one of these courses the student must have completed, with a satisfactory grade, Education 58, or 160, and, in addition, the courses in the subject and related subjects designated as prerequisites to the respective courses in this group. A student who desires to be considered for supervised teaching must complete with a satisfactory grade one of these courses in the subject in which he hopes to do supervised teaching.

AGRICULTURE-EDUCATION (AG-Ed) 89, 90. METHODS OF TEACHING FARM MECHANICS IN VOCATIONAL AGRICULTURE. Mr. Gilman. 1 cr.

AGRICULTURE-EDUCATION (AG-Ed) 92. PROBLEMS IN THE TEACHING OF VOCATIONAL AGRICULTURE. Mr. Annis. 3 cr.

ART-EDUCATION (ART-Ed) 91. PROBLEMS OF TEACHING ART IN ELEMENTARY SCHOOLS. Mr. Thomas. 3 cr.

ART-EDUCATION (ART-Ed) 92. PROBLEMS OF TEACHING ART IN SECONDARY SCHOOLS. Mr. Thomas. 3 cr.

BIOLOGY-EDUCATION (BI-Ed) 91. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL BIOLOGY. Mr. Schaefer. 3 cr.

ENGLISH-EDUCATION (ENG-Ed) 91. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL ENGLISH. Mr. Goffe. 3 cr.

HISTORY-EDUCATION (HIST-Ed) 91. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL HISTORY. 3 cr.

HOME ECONOMICS-EDUCATION (HE-Ed) 91. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL HOME ECONOMICS. 3 cr.

LANGUAGE-EDUCATION (LANG-Ed) 91. PROBLEMS IN THE TEACHING OF FOREIGN LANGUAGES IN THE HIGH SCHOOL. Mr. Chasse. 3 cr.

MATHEMATICS-EDUCATION (MATH-Ed) 91. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL MATHEMATICS. Mr. Balemonos. 3 cr.

MUSIC-EDUCATION (MUS-Ed) 91, 92. PROBLEMS IN THE TEACHING OF ELEMENTARY SCHOOL AND SECONDARY SCHOOL MUSIC. Mr. Whitlock. 3 cr.

PHYSICAL EDUCATION (PE-Ed) 91. PROBLEMS IN THE TEACHING OF PHYSICAL EDUCATION FOR WOMEN. Miss Newman. 3 cr.

Courses in Supervised Teaching

Supervised Teaching is not open to a graduate of another institution unless he first completes an approved program of Teacher Preparation in the University.

Applications for Supervised Teaching must be filed in the office of the Department of Education at least four weeks before the date at which Supervised Teaching begins. These applications must be approved by the Chairman of the Department of Education and the Coordinator of Supervised Teaching. An applicant must complete Education 58 or 160, and must have a sufficient background in a subject-matter field in which he is planning to teach. He must also complete a course in the problems of teaching in his major field. Supervised Teaching, as administered by the Department of Education, is usually a full-time job off campus for one semester.

Students may be enrolled for from 6 to 14 credits of work in Supervised Teaching. Students may count no more than 9 semester credits in Supervised Teaching toward the Master of Education degree.

EDUCATION-AGRICULTURE (ED-AG) 93. SUPERVISED TEACHING IN HIGH-SCHOOL AGRICULTURE. *Prereq.*: Senior Standing in Ag-Ed Curriculum.

EDUCATION-ART (ED-ART) 94. SUPERVISED TEACHING IN SECONDARY SCHOOL ART. *Prereq.*: Art-Ed 92.

EDUCATION-BIOLOGY (ED-BI) 94. SUPERVISED TEACHING IN HIGH-SCHOOL BIOLOGY. *Prereq.*: Bi-Ed 91.

EDUCATION-COMMERCE (ED-Co) 94. SUPERVISED TEACHING IN HIGH-SCHOOL COMMERCIAL SUBJECTS.

EDUCATION-ENGLISH (ED-ENG) 94. SUPERVISED TEACHING IN HIGH-SCHOOL ENGLISH. *Prereq.*: Eng-Ed 91.

EDUCATION-GENERAL SCIENCE (ED-GS) 94. SUPERVISED TEACHING IN GENERAL SCIENCE. *Prereq.*: GS-Ed 91.

EDUCATION-HISTORY (ED-HIST) 94. SUPERVISED TEACHING IN HIGH-SCHOOL HISTORY. *Prereq.*: Hist-Ed 91.

EDUCATION-HOME ECONOMICS (ED-HE) 94. SUPERVISED TEACHING IN HIGH-SCHOOL HOME ECONOMICS. *Prereq.*: HE-Ed 91.

EDUCATION-LANGUAGE (ED-LANG) 94. SUPERVISED TEACHING IN HIGH-SCHOOL FRENCH. *Prereq.*: Lang-Ed 91.

EDUCATION-LATIN (ED-LAT) 94. SUPERVISED TEACHING IN HIGH-SCHOOL LATIN.

EDUCATION-MATHEMATICS (ED-MATH) 94. SUPERVISED TEACHING IN HIGH-SCHOOL MATHEMATICS. *Prereq.*: Math-Ed 91.

EDUCATION-MUSIC (ED-MUS) 93, 94. SUPERVISED TEACHING IN ELEMENTARY AND SECONDARY SCHOOL MUSIC.

EDUCATION-PHYSICAL EDUCATION (ED-PE) (92), 92. DIRECTED TEACHING OF PHYSICAL EDUCATION FOR WOMEN. *Prereq.*: PE-Ed 91 or concurrently. 1 lec. or rec.; 2 2-hr. labs.; 3-6 cr.

EDUCATION-PHYSICAL EDUCATION (ED-PE) 93, (93). DIRECTED TEACHING IN PHYSICAL EDUCATION.

EDUCATION-PHYSICAL EDUCATION (ED-PE) 94. SUPERVISED TEACHING OF PHYSICAL EDUCATION IN THE FIELD.

EDUCATION-SOCIOLOGY (ED-SOC) 94. SUPERVISED TEACHING IN HIGH-SCHOOL SOCIOLOGY. *Prereq.*: Hist-Ed 91.

Elementary Education

Except for Ed. 71-72, courses in Elementary Education are given usually only during the Summer Session and in Extension.

71-72. ELEMENTARY SCHOOL TEACHER PREPARATION. 16 cr. each semester.

73. WORKSHOP IN READING. (Formerly El. Ed. 90.) 3 cr.

74. TEACHING EXCEPTIONAL CHILDREN. 3 cr.

75. THE IMPROVEMENT OF READING. (Formerly El. Ed. 96.) 3 cr.

76. THE TEACHING OF LANGUAGE ARTS IN ELEMENTARY SCHOOLS. (Formerly El. Ed. 69.) 3 cr.

77. CHILDREN'S LITERATURE. (Formerly El. Ed. 67.) 3 cr.

78. READING CLINIC. 3 cr.

79 f, g, s, etc. THE TEACHING OF ELEMENTARY SCHOOL FOREIGN LANGUAGE. (Formerly El. Ed. 65 f, g, s, etc.) 3 cr.

82. THE TEACHING OF ELEMENTARY SCHOOL SOCIAL STUDIES. (Formerly El. Ed. 68.) 3 cr.

84. NEW CONCEPTS IN THE TEACHING OF ARITHMETIC. (Formerly El. Ed. 97.) 3 cr.

85. WORKSHOP IN ARITHMETIC. (Formerly El. Ed. 92.) 3 cr.

86. THE TEACHING OF ELEMENTARY SCHOOL SCIENCE. (Formerly El. Ed. 93.) 3 cr.

89. ELEMENTARY SCHOOL CURRICULUM REORGANIZATION. (Formerly El. Ed. 98.) 3 cr.

95. PRINCIPLES OF ELEMENTARY EDUCATION. 3 cr.

ELECTRICAL ENGINEERING

ALDEN L. WINN, *Chairman*

JOHN B. HRABA, *Graduate Adviser*

To be admitted to graduate study in Electrical Engineering a student should have completed work in his major field equivalent to that currently required of undergraduates at the University of New Hampshire.

All students will be required to complete two basic courses, E.E. 103 (Field Theory) and E.E. 109 (Network Theory) at the beginning of their graduate program or furnish evidence of equivalent preparation. These two courses and those numbered below 100 are normally offered annually. Other courses numbered above 100 are offered on the basis of the requirements of the graduate students. Those who intend to undertake graduate work in Electrical Engineering must consult with the department graduate adviser in order to plan their programs of study. With the consent of the department, a student who through industrial experience has satisfied the objectives of a thesis may be permitted to substitute approved course work for the thesis requirement.

Permission of the instructor is required for enrollment in all elective Electrical Engineering graduate courses.

52. INDUSTRIAL ELECTRONICS FUNDAMENTALS. Application of electronics to industrial processes. (May not be taken for credit by Electrical Engineering majors.) *Prereq.*: Basic Electronics. 2 rec. and 1 lab.; 3 cr.

58. ELECTRONIC SYSTEMS ANALYSIS AND DESIGN. Advanced techniques in network and systems analysis; use of complex frequency and signal flow graphs; coding, transfer, and storage of information. Mr. Frost. 3 rec.; 3 cr.

60. ADVANCED CIRCUIT THEORY. Steady-state and transient analysis, derivation of fundamental formulas and constants; application of LaPlace transforms. Mr. Nulsen. 3 rec.; 1 conf.; 4 cr.; when offered without conference period, 3 cr.

62. ILLUMINATION. Radiation, fundamental processes in gases, atomic spectra, sources of visible and near visible energy, lamp circuitry, lighting and wiring design, control of light, photometry, and color. Mr. Murdoch. 3 rec.; 3 cr.

70. ELECTRICAL ENGINEERING PROJECTS. A laboratory or advanced study course. Each student will either join one of the departmental research projects or engage in a project which is in an area of current staff interest.

Admission to the course will be limited to those accepted by a staff member. 1-4 conf. or 1-2 lab.; 1-4 cr.

78. **INSTRUMENTATION.** Analysis and design of equipment for measurement, instrumentation, and control. Mr. Blanchard. 3 rec.; 1 lab.; 4 cr.

80. **ENGINEERING ANALYSIS.** The basic principles and analytical methods employed in the solution of complex problems in the various branches of engineering. E.E. Staff. 3 rec.; 3 cr.

82. **CONTROL SYSTEMS.** Fundamental principles involved in the design and analysis of feedback control systems. Mr. Blanchard. 3 rec. and 1 lab.; 4 cr.

103. **FIELD THEORY.** The development of Maxwell's Equation; application of vector calculus, boundary values, and conformal mapping to static field problems; and an introductory treatment of the general wave equation. E. E. Staff. 4 rec.; 4 cr.

104. **ELECTROMAGNETIC WAVE THEORY.** Solution of the wave equation in rectangular, cylindrical, and spherical coordinates; reflection and refraction; wave guides and cavities; wave propagation in specialized media; sources; and antenna pattern formations and characteristics. Mr. Frost. 4 rec.; 4 cr.

105. **PRINCIPLES OF MICROWAVE SYSTEMS.** Wave propagation in free space; dielectrics and conductors; normal modes of waveguides and cavities; interactions between traveling waves and electrons; generation at high frequencies. *Prereq.:* E. E. 104. Mr. Frost. 3 rec. and 1 lab. or conf.; 4 cr.

106. **ANTENNAS.** Theory and design of electromagnetic radiating systems. Mr. Frost. *Prereq.:* E. E. 104. 3 rec.; 3 cr.

107-108. **TRANSMISSION AND DISTRIBUTION OF ELECTRIC POWER.** Line characteristics; steady-state performance; symmetrical components; lighting and over-current protection; relaying. Mr. Goodrich. 3 rec.; 3 cr.

109. **NETWORK ANALYSIS.** The application of matrices and determinants, linear graph theory, Laplace and Fourier transforms, complex-variable theory and time-and frequency-domain concepts to the analysis of linear networks and systems. E. E. Staff. 4 rec.; 4 cr.

110. **NETWORK SYNTHESIS.** Characteristics of one-to n-port network functions, realizability criteria and synthesis of one-, two-and three-element-kind driving-point and transfer functions. Mr. Blanchard, Mr. Murdoch. 4 rec.; 4 cr.

111. **NON-LINEAR NETWORKS.** Analysis of passive networks with non-linear and time-varying parameters. Mr. Hraba. 3 rec. and 1 conf.; 4 cr.

112. **NETWORK APPROXIMATION.** Network functions and topologies, dynamic and geometric independence, equivalent networks and the approximation problem in the time and frequency domains. Mr. Murdoch. 4 rec.; 4 cr.

115. **APPLIED ACOUSTICS.** The propagation of acoustical waves in elastic media, characteristics of electro-acoustical transducers, architectural acoustics. Mr. Frost. 3 rec. and 1 lab. or conf.; 4 cr.

117. **ADVANCED ANALYSIS OF ALTERNATING-CURRENT MACHINERY.** Steady-state analysis of synchronous and induction machines. Mr. Hraba. 3 rec.; 3 cr.

118. ANALYSIS OF DYNAMO MACHINES UNDER TRANSIENT CONDITIONS. Analysis of the operation of alternating and direct-current machines with changing voltages and loads. Mr. Hrabá. *Prereq.*: E. E. 117; 3 rec.; 3 cr.

120. ELECTRICAL ENGINEERING PROJECTS. Advanced studies in a specialized field of electrical engineering. E. E. Staff. Admission to the course will be limited to those accepted by a staff member. 1 to 3 conferences or laboratory periods; 1 to 3 cr.

130. LINEAR ACTIVE CIRCUITS. The development of equivalent circuits for solid-state and vacuum tube devices; and the analysis and design of linear networks containing these devices. Mr. Winn. 3 rec.; 1 lab. or conf.; 4 cr.

131. NONLINEAR ACTIVE CIRCUITS. Analytical and graphical techniques for circuits designed for pulse and other non-sinusoidal signals; and solid-state or vacuum tube devices used in the switching mode. Mr. Winn. 3 rec.; 1 lab. or conf.; 4 cr.

135. NON-LINEAR MAGNETIC DEVICES. Magnetic amplifiers with and without feedback; magnetic devices as modulators, frequency multipliers, and in switching circuits; modern theory of magnetism; properties of square-loop magnetic material. Mr. Clark. 3 rec.; 3 cr.

140. INFORMATION THEORY. Introduction to statistical methods; noise sources; noise in linear systems; information transmission; methods of modulation. Mr. Melvin. 3 rec.; 3 cr.

THESIS. Credits to be arranged. 6-10 cr.

ENGLISH

SYLVESTER H. BINGHAM, *Chairman*

The Department of English offers two advanced degrees, the Master of Arts and the Master of Science for Teachers. The Master of Science for Teachers is a terminal degree, one designed for the high school teacher. The Master of Arts is, primarily, the first step to the doctoral degree; the candidate will ordinarily be preparing for teaching in a college or university. The high school teacher may, however, pursue either degree.

For the Master of Arts degree a reading knowledge of French, German, or Latin is required of the candidate. For the Master of Science for Teachers degree no foreign language is required.

The student who is a candidate for the degree of Master of Science for Teachers must take thirty hours of work in English numbered above 50 that will not be a repetition of his undergraduate course work.

The student who is a candidate for the Master of Arts degree must earn thirty credits: no more than twelve in literature courses numbered 55-99; twelve in literature courses numbered 155-199 (six of which must be in graduate seminars); and six credits in a thesis. A student taking a course numbered 155-

199, though attending the undergraduate lectures, must do additional work assigned by his instructor and prepare a paper on an agreed subject connected with his study.

All graduate students, even though they attend undergraduate classes, are marked on the graduate level.

If a student intends to complete his work for the master's degree in one year, he should register for three thesis credits each semester.

55, 56. CHAUCER. Mr. Underwood. 3 cr.

57, 58. SHAKESPEARE'S PLAYS. The major histories, comedies, and tragedies. Mr. Schultz and Mr. Yarrington. 3 cr.

59. MILTON. Mr. Schultz. 3 cr. (Alternate years; offered in 1963-64.)

60. BOSWELL'S JOHNSON. Mr. Maynard. 3 cr. (Not offered in 1963-64.)

61. WORDSWORTH. Mr. Miller. 3 cr. (Alternate years; not offered in 1963-64.)

62. BROWNING. Mr. Daggett. 3 cr. (Alternate years; offered in 1963-64.)

63, 64. ENGLISH LITERATURE IN THE SIXTEENTH CENTURY. Mr. Schultz. 3 cr. (Alternate years; not offered in 1963-64.)

65, 66. ENGLISH LITERATURE IN THE SEVENTEENTH CENTURY. 3 cr. (Alternate years; not offered in 1963-64.)

67, 68. ENGLISH LITERATURE IN THE EIGHTEENTH CENTURY. Mr. Maynard. 3 cr. (Alternate years; offered in 1963-64.)

69, 70. THE ENGLISH ROMANTIC PERIOD. Wordsworth, Coleridge, Lamb, Hazlitt, Byron, Shelley, Keats, DeQuincey. Mr. Miller. 3 cr. (Alternate years; offered in 1963-64.)

71, 72. VICTORIAN PROSE AND POETRY. Major non-fictional prose from Carlyle to Stevenson and major poetry from Tennyson to Hardy. Mr. Miller. 3 cr. (Alternate years; not offered in 1963-64.)

73, 74. BRITISH LITERATURE OF THE TWENTIETH CENTURY. Mr. Richardson. 3 cr. (Alternate years; not offered in 1963-64.)

75. NEW ENGLAND RENAISSANCE. Emerson, Thoreau, and other transcendentalists. Mr. Daggett. 3 cr. (Alternate years; not offered in 1963-64.)

76. AMERICAN NOVEL IN THE NINETEENTH CENTURY. Mr. Webster. 3 cr. (Alternate years; not offered in 1963-64.)

77. AMERICAN POETRY OF THE NINETEENTH CENTURY. Mr. Daggett. 3 cr. (Alternate years; offered in 1963-64.)

79, 80. AMERICAN LITERATURE OF THE TWENTIETH CENTURY. Mr. Nicoloff. 3 cr. (Alternate years; offered in 1963-64.)

81, 82. INTRODUCTION TO ENGLISH DRAMA. The development of English drama, exclusive of Shakespeare, from the Middle Ages to the present. Mr. Yarrington. 3 cr. (Alternate years; offered in 1963-64.)

83, 84. THE ENGLISH NOVEL OF THE EIGHTEENTH AND NINETEENTH CENTURIES. Mr. Bingham and Mr. Miller. 3 cr.

85. EXPOSITORY WRITING. Limited to students in the teacher preparation program and graduate students working for the M.S.T. degree. 3 cr.

86. ENGLISH GRAMMAR. Mr. Goffe. Limited to students in the teacher preparation program and graduate students working for the M.S.T. degree. (Not open to students who have had Engl. 27.) 3 cr.

87, 88, 89. CRITICAL ANALYSIS. Analysis of three forms of writing: 87, Exposition; 88, Fiction; 89, Poetry. Mr. Bingham and Mr. Richardson. (Not open to students who have had Engl. 43, 44, 45.) 3 cr.

155, 156. CHAUCER. 3 cr.

157, 158. SHAKESPEARE. 3 cr.

159. MILTON. 3 cr. (Alternate years; offered in 1963-64.)

160. BOSWELL'S JOHNSON. 3 cr. (Not offered in 1963-64.)

161. WORDSWORTH. 3 cr. (Alternate years; not offered in 1963-64.)

162. BROWNING. 3 cr. (Alternate years; offered in 1963-64.)

163, 164. ENGLISH LITERATURE IN THE SIXTEENTH CENTURY. 3 cr. (Alternate years; not offered in 1963-64.)

165, 166. ENGLISH LITERATURE IN THE SEVENTEENTH CENTURY. 3 cr. (Alternate years; not offered in 1963-64.)

167, 168. ENGLISH LITERATURE IN THE EIGHTEENTH CENTURY. 3 cr. (Alternate years; offered in 1963-64.)

169, 170. THE ENGLISH ROMANTIC PERIOD. 3 cr. (Alternate years; offered in 1963-64.)

171, 172. VICTORIAN PROSE AND POETRY. 3 cr. (Alternate years; not offered in 1963-64.)

173, 174. BRITISH LITERATURE OF THE TWENTIETH CENTURY. 3 cr. (Alternate years; not offered in 1963-64.)

175. THE NEW ENGLAND RENAISSANCE. 3 cr. (Alternate years; not offered in 1963-64.)

176. THE AMERICAN NOVEL IN THE NINETEENTH CENTURY. 3 cr. (Alternate years; not offered in 1963-64.)

177. AMERICAN POETRY OF THE NINETEENTH CENTURY. 3 cr. (Alternate years; offered in 1963-64.)

179, 180. AMERICAN LITERATURE OF THE TWENTIETH CENTURY. Mr. Nicoloff. 3 cr. (Alternate years; offered in 1963-64.)

181, 182. AN INTRODUCTION TO ENGLISH DRAMA. Mr. Yarrington. 3 cr. (Alternate years; offered in 1963-64.)

183, 184. THE ENGLISH NOVEL OF THE EIGHTEENTH AND NINETEENTH CENTURIES. 3 cr.

185, 186. SEMINAR. Problems in Medieval Literature. Mr. Underwood. 3 cr.

187. SEMINAR. Problems in Literature and Thought. 1570 to 1670. Mr. Schultz. 3 cr.

THESIS. 6 cr.

ENTOMOLOGY

JAMES G. CONKLIN, *Chairman*

For admission to graduate study in Entomology an applicant is expected to have had adequate preparation in undergraduate Entomology and related sciences. Students lacking the necessary background courses may be required to complete certain courses which do not carry graduate credit before they are admitted to candidacy for a degree.

The program of graduate study is designed to meet the needs of those students who are planning to take further work leading to a career in professional Entomology.

A thesis is required of all candidates for the Master's degree.

54. MEDICAL ENTOMOLOGY. Insects and arachnids in relation to public health. The more important disease carriers, their biologies, and means of control. Adapted especially for students who are interested in public health or medicine. Elective for juniors and seniors. Mr. Blickle. 2 lec.; 1 lab.; 3 cr.

57-58. ADVANCED ENTOMOLOGY. The anatomy and physiology of insects. Systematic entomology. Mr. Conklin, Mr. Blickle, Mr. Lee. Open to others than Entomology majors by permission of the Department Chairman. 2 lec.; 2 lab.; 4 cr.

59-60. ADVANCED ECONOMIC ENTOMOLOGY. Problems in applied Entomology and apiculture; the literature of economic entomology. Investigational methods. Studies of the specialized phases of entomology. Mr. Conklin, Mr. Blickle, Mr. Lee. Required of Entomology majors. Open to others than Entomology majors by permission of the Department Chairman. 1 to 3 cr.

101, 102. GRADUATE ENTOMOLOGY. Mr. Conklin, Mr. Blickle, Mr. Lee. Hours and credits to be arranged.

103, 104. GRADUATE ENTOMOLOGY. THESIS. Mr. Conklin, Mr. Blickle, Mr. Lee. Hours and credits to be arranged.

FOREIGN LANGUAGES AND LITERATURES

R. ALBERTO CASAS, *Chairman*

The Department of Foreign Languages and Literatures offers courses leading to two degrees: Master of Arts and Master of Science for Teachers.

To be admitted to graduate study for the M.A. degree in a foreign language, the student must have met requirements substantially equal to those set up for an undergraduate major in the Department of Foreign Languages and Literatures at the

University of New Hampshire. The student must submit an acceptable thesis embodying the results of independent investigation (equivalent to six semester credits in courses primarily for graduate students). The thesis must be presented before April 20 of the academic year in which the degree is to be granted. Before undertaking thesis work, the student must pass a comprehensive written examination in the language and literature of his major field of specialization. The examination will be given four times a year: January, May, August, and September. The candidate will be permitted only two opportunities to take this comprehensive examination. In case of failure in the first attempt, a re-examination may not be taken within three months. The student must complete at least 30 credits of graduate work with a minimum of 18 credits in his major language, exclusive of the thesis. Six credits in courses in General Language and Literature, listed below, may be counted toward the degree.

A student taking a course numbered 151-199 must register for the graduate course and pass, in partial fulfillment, with a grade of B or better, the corresponding undergraduate course numbered 51-99. At the same time he must do additional work assigned by the instructor and prepare a paper on an agreed subject connected with his study. A student should not register for a graduate course if he has previously taken the corresponding undergraduate course.

To be admitted to graduate study for the M.S.T. degree in a foreign language, a candidate must have satisfactorily completed the requirements for secondary school teacher certification in a foreign language. Courses leading to this degree will normally be chosen from Summer Session and National Defense Education Foreign Language Institute offerings and require 30 semester hours of work at the graduate level. Secondary school teachers interested in this degree should consult the Chairman of the Department.

General Language and Literature

72. APPLIED LINGUISTICS. This course is designed to acquaint teachers and others with the techniques and practical application of modern structural linguistics. Mr. Cryesky. *Prereq.*: Permission of the instructor. 3 cr.

73. INTRODUCTION TO ROMANCE PHILOLOGY. The historical development of French and Spanish from Vulgar Latin. Phonology, morphology, syntax, semantics, etymology. Frequent reference is made to the spoken languages of today as well as to comparative semantics. Mr. Cryesky. *Prereq.*: Permission of instructor. 3 cr. (Not offered in 1963-64.)

LANGUAGES-EDUCATION (LANG-ED) 91. PROBLEMS IN THE TEACHING OF MODERN LANGUAGE IN THE HIGH SCHOOL. The special objectives, methods, and devices of modern language teaching in high school. For prospective or

actual teachers of French, German, and Spanish. *Prereq.*: Intermediate French, German, Spanish; and grade of C or better in Education 58, or one year's teaching experience.

French

59-60. FRENCH LITERATURE OF THE SEVENTEENTH CENTURY. 59 Historical and literary background of French classicism, poetry, Corneille, Pascal, and Molière's early plays. 60 Molière, Racine, LaFontaine, Mme. de LaFayette, Boileau, and LaBruyère. Lesage, the beginning of the philosophical movement. Conducted in French. *Prereq.*: French 6. 3 cr. (Not offered in 1963-64.)

64. EIGHTEENTH CENTURY FRENCH LITERATURE AND THOUGHT. The literary and philosophical currents, including Montesquieu, Marivaux, Rousseau, Voltaire, the encyclopedistes, Beaumarchais, and others. Conducted in French. *Prereq.*: French 6. 3 cr. (Not offered in 1963-64.)

67-68. NINETEENTH CENTURY FRENCH LITERATURE. 67 Romanticism; Mme. de Stael, Chateaubriand, Lamartine, Hugo, Vigny, Musset. 68 Late Romanticism; Realism; Stendahl, Balzac, Flaubert, Hugo, the Parnassian school. Conducted in French. *Prereq.*: French 6. 3 cr. (Offered in 1963-64.)

70. INTRODUCTION TO MODERN FRENCH POETRY. Baudelaire, Rimbaud, Mallarmé, Valéry and others. *Prereq.*: French 6. 3 cr. (Offered in 1963-64.)

73, 74, 75, 76. SPECIAL STUDIES IN FRENCH LANGUAGE AND LITERATURE. Individual guided study in special topics, with training in bibliography, note taking, and organization of material. Examples of topics which may be selected are: the work of a major French author, specific topics in any area of French literature, such as literary criticism in the Seventeenth Century. The Staff. *Prereq.*: Permission of the Chairman of the Department. 3 cr.

81-82. CONTEMPORARY FRENCH NOVEL AND THEATER. 81. Zola, the Goncourts, Proust, Gide, Becque, Maeterlinck, and others. 82. Mauriac, Malraux, Bernanos, Sartre, Camus, Claudel, Pagnol, Anouilh, Giraudoux, and others. Conducted in French. *Prereq.*: French 6. 3 cr. (Not offered in 1963-64.)

90. ADVANCED LANGUAGE AND STYLE. Translation of literary texts, intensive study of the principal techniques of style, *explication de textes*. Open to qualified students who have had a minimum of six hours of French courses numbered 41 and above. 3 cr. (Offered in 1963-64.)

159, 160. FRENCH LITERATURE OF THE SEVENTEENTH CENTURY. *Prereq.*: French 6. 3 cr. (Not offered in 1963-64.)

164. EIGHTEENTH CENTURY FRENCH LITERATURE AND THOUGHT. *Prereq.*: French 6. 3 cr. (Not offered in 1963-64.)

167, 168. NINETEENTH CENTURY FRENCH LITERATURE. *Prereq.*: French 6. 3 cr. (Offered in 1963-64.)

170. INTRODUCTION TO MODERN FRENCH POETRY. *Prereq.*: French 6. 3 cr. (Offered in 1963-64.)

173, 174, 175, 176. SPECIAL STUDIES IN FRENCH LANGUAGE AND LITERATURE. *Prereq.*: Permission of the Chairman of the Department. 3 cr.

181-182. CONTEMPORARY FRENCH NOVEL AND THEATER. *Prereq.*: French 6. 3 cr. (Not offered in 1963-64.)

190. **ADVANCED LANGUAGE AND STYLE.** *Prereq.:* Open to qualified students who have had a minimum of six hours of French courses numbered 41 and above. 3 cr. (Offered in 1963-64.)

German

56. **GERMAN LITERATURE OF THE AGE OF THE BAROQUE AND ENLIGHTENMENT.** A survey of German literature between Reformation and the Age of Goethe. Reading, interpretation, and critical analysis of prescribed prose, drama, and poetry. *Prereq.:* German 5-6. 3 cr. (Offered in 1963-64.)

57, 58. **THE AGE OF GOETHE.** German literature of Storm and Stress and the Classical Period. Interpretation and critical analysis with emphasis upon selected works of Lenz, Klinger, Schiller, and Goethe. *Prereq.:* German 6. 3 cr. (Offered in 1963-64.)

59. **GERMAN ROMANTICISM.** Interpretation and critical analysis of prescribed prose, drama, and poetry of Kleist, Novalis, Tieck, Schlegel, Brentano, Eichendorff. *Prereq.:* German 6. 3 cr. (Offered in 1964-65.)

62. **GERMAN REALISM.** German literature from the end of Romanticism to Naturalism, with presentation of the social and philosophical development of the period (1830-1880). *Prereq.:* German 6. 3 cr. (Offered in 1964-65.)

63, 64. **GERMAN LITERATURE SINCE 1880.** From Naturalism to the present. Reading, interpretation, and critical analysis of prescribed prose, drama, and poetry of Hauptmann, Hofmannstal, Rilke, Mann, Kafka. *Prereq.:* German 6. 3 cr. (Offered in 1964-65.)

73, 74, 75, 76. **SPECIAL STUDIES IN GERMAN LITERATURE.** Individual guided study in special topics, with training in bibliography, note taking, organization of material. Examples of topics which may be selected by instructor and student in conference are: (a) Middle High German Popular Epics; (b) German Literature of the 17th Century; (c) Goethe's Poetry; (d) Goethe's Faust; (e) Heinrich v. Kleist; (f) German Romanticism; (g) 20th Century German literature. *Prereq.:* Permission of Chairman of the Department. 3 cr.

90. **ADVANCED STYLISTICS.** A systematic study of style, shades of meaning, adequacy of expression. A thorough knowledge of German grammar is prerequisite. A course specially designed for students who plan to attend a German university. Practice in writing seminar papers, taking classroom notes, and obtaining stylistic flexibility in the use of written German. *Prereq.:* German 5-6. 3 cr.

156. **GERMAN LITERATURE OF THE AGE OF THE BAROQUE AND ENLIGHTENMENT.** *Prereq.:* German Civilization and Literature. 3 cr.

157, 158. **THE AGE OF GOETHE.** *Prereq.:* German Civilization and Literature. 3 cr.

159. **GERMAN ROMANTICISM.** *Prereq.:* German Civilization and Literature. 3 cr.

162. **GERMAN REALISM.** *Prereq.:* German Civilization and Literature. 3 cr.

163, 164. **GERMAN LITERATURE SINCE 1880.** *Prereq.:* German Civilization and Literature. 3 cr.

173, 174, 175, 176. SPECIAL STUDIES IN GERMAN LITERATURE. *Prereq.*: Permission of Chairman of the Department. 3 cr.

190. ADVANCED STYLISTICS. *Prereq.*: German Civilization and Literature. 3 cr.

Latin

51-52. PHILOSOPHY AND SATIRE. Philosophy, religion, natural science, and social theories of the Romans, as exemplified in the writings of Horace, Martial, and Cicero. *Prereq.*: Latin 6 or the equivalent. 3 cr.

53-54. THE HISTORIANS. Livy, Suetonius, and Tacitus in selected works. Illustrated lectures and outside readings on the historical, social, and political background of Rome, essential to the student or teacher of Latin. *Prereq.*: Latin 6 or equivalent. 3 cr.

55-56. THE GOLDEN AGE. Roman literature of the classical period, particularly the works of Caesar, Cicero, and Virgil. *Prereq.*: Latin 6 or its equivalent. 3 cr.

71, 72, 73, 74. SPECIAL STUDIES IN LATIN LITERATURE. Guided studies in special topics with training in bibliography and organization of material. Examples of topics which may be selected by instructor and student are: (a) Roman Comedy and Elegy, (b) The Roman Epic, (c) Roman Drama, (d) The Silver Age. Mr. Doig. *Prereq.*: Permission of the Chairman of the Department. 3 cr.

LATIN-EDUCATION (LAT-ED) 91-92. PROBLEMS IN THE TEACHING OF HIGH-SCHOOL LATIN. The study of methods, objectives, and problems of teaching high-school Latin will be carried on throughout the year concurrently with work in composition and conversation. *Prereq.*: Permission of the instructor. 3 cr. (Not offered in 1963-64.)

151-152. PHILOSOPHY AND SATIRE. *Prereq.*: Latin Prose and Poetry or the equivalent. 3 cr.

153-154. THE HISTORIANS. *Prereq.* Latin Prose and Poetry or the equivalent. 3 cr.

155-156. THE GOLDEN AGE. *Prereq.*: Latin Prose and Poetry or the equivalent. 3 cr.

171, 172, 173, 174. SPECIAL STUDIES IN LATIN LITERATURE. *Prereq.*: Permission of the Chairman of the Department. 3 cr.

Spanish

51. SPANISH LITERATURE UP TO 1600 AND CERVANTES. Readings and discussion of the general human creations of early Spanish Literature such as *El Poema de Mio Cid*, *El Libro de Buen Amor*, *La Celestina* and *Don Quijote*, and their social and historical background. The first part of the course will cover early Spanish literature up to Cervantes. The second part of the course will be devoted entirely to Cervantes: his life, drama, *Novelas Ejemplares*, and his masterpiece *Don Quijote*. *Prereq.*: Spanish 6 or equivalent. 3 cr. (Offered in 1963-64.)

52. DRAMA AND POETRY OF THE SIGLO DE ORO. Discussion of the social background of the baroque period and readings of the representative plays

of Lope de Vega, Calderon, Alarcon, Tirso de Molina, and the poetry of Gongora and Quevedo. Development of the prose of the period. *Prereq.*: Spanish 6 or equivalent. 3 cr. (Offered in 1963-64.)

55. LITERATURE OF THE NINETEENTH CENTURY. After a preliminary survey of the Eighteenth Century this course will cover the readings and discussion of the main literary movements and writers of the Nineteenth Century such as: Quintana, Espronceda, Zorrilla, Larra, Duque de Rivas, Becquer, Perez Galdos, Valera, Pereda, Clarin, and Echegaray. Social and historical background of Spain in relation to Nineteenth Century thought in Europe. *Prereq.*: Spanish 6 or equivalent. 3 cr. (Not offered in 1963-64.)

56. CONTEMPORARY SPANISH LITERATURE. Starting with the generation of '98, this course will cover the readings and discussion of the works of such writers as Unamuno, Azorin, Baroja, Machado, J. R. Jimenez, Ortega y Gasset, Garcia Lorca, Perez de Ayala, Casona, Benavente, and a survey of Spanish literature and thought since 1939. *Prereq.*: Spanish 6 or equivalent. 3 cr. (Not offered in 1963-64.)

65, 66. SPANISH AMERICAN LITERATURE. Lectures and discussion on the main themes of Spanish American literature through the readings of the works of the most representative authors along with a historical, social and geographical background of the New World. *Prereq.*: Spanish 6 or equivalent. 3 cr. (Not offered in 1963-64.)

73, 74, 75, 76. SPECIAL STUDIES IN SPANISH LANGUAGE AND LITERATURE. Individual guided study in special topics, with training in bibliography, note taking, and organization of material. Examples of topics that may be selected by instructor and student in conference are: (a) 18th, 19th, or 20th century literature in Spain; (b) literature and civilization in Spain in the Golden Age; (c) the literature of individual Latin-American countries; (d) literary relations of Europe and Latin-America. The Staff. *Prereq.*: Permission of Chairman of the Department. 3 cr.

151. SPANISH LITERATURE UP TO 1600 AND CERVANTES. *Prereq.*: Spanish 6 or equivalent. 3 cr. (Offered in 1963-64.)

152. DRAMA AND POETRY OF THE SIGLO DE ORO. *Prereq.*: Spanish 6 or equivalent. 3 cr. (Offered in 1963-64.)

155. LITERATURE OF THE NINETEENTH CENTURY. *Prereq.*: Spanish 6 or equivalent. 3 cr. (Not offered in 1963-64.)

156. CONTEMPORARY SPANISH LITERATURE. *Prereq.*: Spanish 6 or equivalent. 3 cr. (Not offered in 1963-64.)

165-166. SPANISH AMERICAN LITERATURE. *Prereq.*: Spanish 6 or equivalent. 3 cr.

173, 174, 175, 176. SPECIAL STUDIES IN SPANISH AND LITERATURE. *Prereq.*: Permission of the Chairman of the Department. 3 cr.

FORESTRY

PAUL E. BRUNS, *Chairman*

Students admitted to graduate study in Forestry are expected to have completed a course of study equivalent to that required for the degree of Bachelor of Science in Forestry. Those who

lack undergraduate training in any of the necessary fields may be required to complete certain courses in these subjects without graduate credit before being admitted to candidacy for a degree.

Candidates for the Master's degree in Forestry must pass an oral examination. A thesis may or may not be required, as determined by the department staff.

51, 52. **FOREST UTILIZATION.** Methods of logging and milling in the chief lumber-producing regions of the United States; forest products, their manufacture and markets; with special problems of the lumber business. Mr. Swain. *Prereq.*: Permission of the instructor. 2 lec.; 1 4-hr. lab.; 4 cr.

53. **WILDLIFE ECOLOGY PROBLEMS.** Summer Camp course. Special problems in the ecology of forest fish and game. Mr. Stevens. Open to advanced students or to those who show unusual promise in wildlife research. *Prereq.*: Permission of the instructor. Forty hours per week for 8 weeks. 10 cr.

55, 56. **FOREST GAME MANAGEMENT.** Readings and discussions on the properties of game populations, and the various phases of management, including public relations. The principles of forest management, and the preparation of a working plan for the management of forest and wildlife resources on a specified area. The student may be required to spend several week-ends working with the State Fish and Game Department, helping with investigational projects. Mr. Stevens. 2 lec.; 1 4-hr. lab.; 4 cr.

57. **AERIAL PHOTOGRAMMETRY IN FORESTRY.** Elementary principles of photogrammetry with emphasis on their application to all phases of forestry. The value and use of aerial photos in forest typing, planimetric, and topographic mapping; measurement of area and volume estimation. 2 lec.; 2 lab.; 4 cr.

59. **FOREST PROTECTION.** Principles of protection from fire, insects, fungi, climatic extremes, and other injurious agencies. Principles are illustrated by protection problems of northeastern forests. Emphasis is placed upon the development of resistant forest stands. Mr. Allen. 2 lec.; 1 lab.; 3 cr.

63. **FOREST RECREATION.** The extent, developments, and conflicts in the recreational use of wild lands of North America. Relationships to the conservation of natural resources are considered. *Prereq.*: Permission of the instructor. Mr. Wallace. 3 lec.; 3 cr

64. **FOREST INDUSTRY ECONOMY.** Economy in productive enterprise — logging and manufacturing of forest products; control of harvesting costs as a factor in intensifying applied forest management; planning for minimum cost operations. Mr. Wallace. *Prereq.*: Permission of the instructor. 2 lec.; 1 lab.; 3 cr.

66. **WOOD IDENTIFICATION.** The use of lumber; physical properties and identification of the commercially important woods. Mr. Swain. *Prereq.*: Permission of the instructor. 2 lec.; 1 lab.; 3 cr.

(69). **FOREST MANAGEMENT.** The management of forest areas on an economic and ecological basis. The integration and application of business methods and the technical phases of forestry. Mr. Bruns. *Prereq.*: Permission of the instructor. Not for students with undergraduate forestry degrees. 2 lab.; 4 cr.

101, 102. **FOREST MANAGEMENT SEMINAR.** Seminar discussions of current literature, plans and principles, and new developments in the general field of forest management. Mr. Bruns and members of the department. 2 lec.; 2 cr. *Prereq.*: Permission of the instructor.

(104). **APPROACH TO RESEARCH.** A consideration of the meaning of science and the scientific method. The application of logic in the scientific method. A consideration of the general principles and techniques of scientific research. A general survey of statistical procedures as a tool for research. The organization of investigative work including problem analyses, working plans, and the preparation of reports. Mr. Allen, Mr. Wallace, Mr. Hocker, and others. 2 lec.; 2 cr. *Prereq.*: Permission of the instructor.

105, 106. **UTILIZATION SEMINAR.** Conferences, discussions and reports on assigned topics. Consideration of current literature, and developments in the general field of wood utilization. Mr. Swain. Two-hour seminar; 2 cr. *Prereq.*: Permission of the instructor.

109, 110. **WILDLIFE MANAGEMENT SEMINAR.** Discussions and assigned reports on current investigations and developments in wildlife management. Mr. Stevens. Two-hour seminar; 2 cr. *Prereq.*: Undergraduate courses in wildlife management.

115. **MENSURATION.** Volume table construction and application, advanced studies of growth and yield and methods of prediction. Application of graphic and statistical solutions to these problems. 2 lec.; 1 lab.; 3 cr. *Prereq.*: Permission of the instructor.

117, (117). **AERIAL PHOTOGRAMMETRY.** The application of aerial photogrammetrical techniques to specific forestry problems. A more detailed consideration of the use of aerial photographs for volume estimation including cull, volume tables, and species composition. The use of aerial photographs in fire control, range, timber and recreational management, road location, and allocation of cut. A consideration of the use of aerial photographs in designing large-scale resource inventories. 2 lec.; 2 cr. *Prereq.*: Permission of the instructor.

131, 132. **FOREST UTILIZATION.** The relationship of regional conditions to logging practices in the principal lumber producing areas of the United States. The manufacture of forest products with reference to raw material and markets; special problems in wood utilization. Mr. Swain. 2 lec.; 4-hr. lab.; 4 cr. *Prereq.*: Permission of the instructor.

133. **FOREST PROTECTION SEMINAR.** Discussion and special problems based on the principles and techniques of forest protection. Mr. Allen. 3 lec.; 3 cr. *Prereq.*: For. 59 or equivalent.

161, 162. **PROBLEMS IN (A) FOREST ECOLOGY, (B) PHOTOGRAMMETRY, (C) FOREST UTILIZATION, (D) GAME MANAGEMENT, (E) MENSURATION, (F) FOREST ECONOMICS, (G) FOREST MANAGEMENT.** Work to be arranged according to the needs of individual students. Staff. Hours to be arranged. 2 to 4 cr. *Prereq.*: Permission of the instructor

THESIS. Hours and credits to be arranged to meet the needs of the individual student. 6-10 cr. *Prereq.*: Graduate standing, and the permission of the instructor in the selected field of study.

GOVERNMENT

JOHN T. HOLDEN, *Chairman*

A candidate for the degree of Master of Arts in Government is required to complete at least 30 credits of acceptable work. In addition the candidate must show evidence through a written examination of a mastery in three basic areas in Government agreed upon between the student and his adviser. At the option of the Chairman of the Department, any student may be orally examined on his thesis by a Committee selected by the Chairman and approved by the Dean of the Graduate School. He shall show evidence of competence in one foreign language or in statistics.

Generally his program shall consist of 18 credits in Government courses, including 6 credits for the thesis, and 12 credits in courses from related fields. Government courses shall be selected from those numbered 101-199. The seminars numbered 197 and (197) are to be given priority in the programs of all graduate students. With the consent of the adviser, 3 credits may be selected in courses numbered 51-99.

The Department also offers a Master of Public Administration degree.

51. ADMINISTRATION OF JUSTICE. The nature, sources and problems of the law as distinguished from other forms of social control. The course is analytical and critical, tracing the origin and development of legal institutions from primitive times to the present and evaluating the modern role of judge, jury, and counsel in the administration of justice. The law in action, i.e., law as it is applied by courts and practiced by lawyers rather than as it is formulated by the legislative and executive branches. Mr. Dishman. 3 lec. or rec.; 3 cr.

52. THE SUPREME COURT AND THE AMERICAN CONSTITUTION. The American Constitution, stressing the basic constitutional principles on which the American political system is founded and their application to present-day social, political, and economic problems. The powers of Congress, the President, and the federal courts and the constitutional limitations by which their respective powers are checked. Mr. Dishman. *Prereq.*: Gov. 6. 3 lec. or rec.; 3 cr.

55. WORLD POLITICS. The basic driving forces in international relations including the nature of political power and its extension or limitation. Geopolitics, nationalism, ideology, imperialism, international economic relations, balance of power, warfare, regulation of arms, international law, and collective security. Mr. Holden and Mr. Kuusisto. 3 lec. or rec.; 3 cr.

56. FOREIGN POLICIES OF THE GREAT POWERS. Fundamental factors influencing contemporary foreign policy formulation in the United States, the Soviet Union, the British Commonwealth, and other significant powers. Problems and choices confronting policy makers of these powers in dealing with issues involving the United Nations, regional organizations, Western Europe, Middle East, and Asia. Mr. Kuusisto and Mr. Holden. 3 lec. or rec.; 3 cr.

57. **THE ADMINISTRATIVE PROCESS.** The principal concepts of governmental administration, including theories of organization, administrative leadership, internal management, and administrative responsibility and control. The relationship of group behavior and policy development to the administrative process. Mr. Drake. *Prereq.:* Gov. 6 or Soc. 1. 3 lec.; 3 cr.

58. **NATURAL RESOURCES POLICY AND ADMINISTRATION.** The development and administration of public policy on land, water, and mineral resources. Special attention will be given to the historical development of governmental action in each of these areas, political conflicts on policy goals, and the administrative structure for carrying out current policies. Mr. Knapp. *Prereq.:* Gov. 6. 3 lec. or rec.; 3 cr. (Not offered in 1962-63.)

63. **POLITICAL THOUGHT IN THE WEST.** The principal political theories from Plato and Aristotle to the beginning of the modern liberal tradition. The growth and development of political thinking and institutions in terms of the development of modern government. The development of the modern nation state and its fundamental institutions. Mr. Holden. 3 lec. or rec.; 3 cr.

64. **MODERN POLITICAL THOUGHT.** Modern Western political thought from the emergence of the nation state to the present. The meaning and growth of the basic patterns of thought on the Continent and in England, including liberalism, democracy, nationalism, socialism, communism, and fascism. The contributions of American political thought as it grew from its English origins to the development of the American constitutional system. Mr. Holden. 3 lec. or rec.; 3 cr. (Alternate years; not offered in 1963-64.)

65, (65). **RESEARCH IN GOVERNMENT PROBLEMS.** An individual research project in one of the fields of government, e.g., local or state administration, comparative government, international relations, international organization, political theory, politics, or public law to be prepared under the direction of the instructor. Emphasis will be placed on the methods and sources of research in government. Mr. Dishman. 3 cr.

(69.) **CONTEMPORARY SOUTHEAST ASIA.** A comparative study of the political and social development of Southeast Asia. The course will stress the significance of the role of independence and dependence; the competing influence of communism and Western democracy; the special significance of the role of China, India, Great Britain, and the United States. The states to be studied include the Philippines, Laos, Cambodia, Viet Nam, Viet Minh, Thailand, Burma, Malaya, and Indonesia. Mr. Holden. 3 lec. or rec.; 3 cr. (Alternate years; offered in 1963-64.)

97, (97). **SEMINAR IN GOVERNMENT.** A selected current topic from government, political philosophy and history, political behavior, public law, public administration, or international relations will be the vehicle for this seminar. Special emphasis will be given in 1962-63 to an area approach (Southeast Asia, for example) in the study of international relations. Each student is held responsible for a specific phase of the selected problem. He will also, through the techniques of the seminar, acquaint himself with the whole project. The course is restricted to undergraduates with honor grades and graduate students in Social Science. Advance copies of the syllabus may be secured from the Chairman of the Department. Permission of the instructor is required. Mr. Holden, Mr. Dishman, Mr. Kuusisto, Mr. Bradford, Mr. Drake. 3 lec. or rec.; 3 cr.

READING AND RESEARCH IN GOVERNMENT AND POLITICAL SCIENCE. With the advice and consent of the instructor, graduate students in social science who

demonstrate the ability to do independent work may register for a reading and research course. The student will attend the regular lectures, meet the required examinations, follow a prescribed reading program, and write a paper in lieu of a final examination. 3 cr.

152. THE SUPREME COURT AND THE AMERICAN CONSTITUTION. Mr. Dishman.

154. POLITICAL BEHAVIOR. Mr. Dishman.

155. TOPICS IN WORLD POLITICS. Mr. Holden.

156. TOPICS IN FOREIGN POLICIES OF GREAT POWERS. Mr. Kuusisto.

157. ADMINISTRATIVE PROCESS. Mr. Drake.

158. THE POLICY AND ADMINISTRATION OF NATURAL RESOURCES. Mr. Knapp.

159. PROBLEMS IN POLICY MAKING IN NATURAL RESOURCES. Mr. Knapp.

160. COMPARATIVE ADMINISTRATION.

(161). AMERICAN NATIONAL, STATE, AND LOCAL ADMINISTRATION. This course generally follows the Administrative Process (157) and deals with various specialized aspects of administrative practice in the United States, including policy formation in administrative settings, rule making, administrative adjudication, and policy control. Mr. Drake. 3 lec.; 3 cr.

162. ADMINISTRATIVE DECISION-MAKING.

163. AMERICAN POLITICAL THOUGHT. Mr. Holden.

164. MODERN POLITICAL THOUGHT. Mr. Holden.

169. TOPICS IN ASIAN AND AFRICAN POLITICS. Mr. Holden and Mr. Bradford.

197, (197). SEMINAR. (See Government 97.) Mr. Holden, Mr. Dishman, Mr. Kuusisto, Mr. Bradford, Mr. Drake.

THESIS. To be arranged. 6-9 cr.

HISTORY

MARION E. JAMES, *Chairman*

In general, the candidate for admission to graduate study in History should present evidence of having satisfactorily completed at least 24 semester credits as an undergraduate, in courses in History, not including courses open to freshmen, with a grade of C or better. The History Department, however, reserves the right to judge each applicant on his individual merits. The requirements for the degree of Master of Arts in History are those stated on pages 17, 18, and 19 of this catalogue. The completed thesis must be submitted by April 1 of the year in which the degree is to be granted. A final examination is not required.

51, 52. COLONIAL AND REVOLUTIONARY AMERICAN HISTORY. Colonial beginnings in America, national rivalries, the English colonies, the Revolu-

tion, and our national life to 1789. Early forms of Americanism in the making. Mr. Marston. 3 cr.

65, 66. **MEDIEVAL HISTORY.** History of Europe and the Mediterranean area from the late Roman Empire to the Renaissance. Mr. Jones. 3 cr.

67. **RENAISSANCE AND REFORMATION.** The history of Europe during the fifteenth and sixteenth centuries with primary emphasis on the Italian Renaissance, the Protestant Reformation, and the emergence of the national state. Mr. Gilmore. 3 cr.

70. **TWENTIETH CENTURY EUROPE.** European history in the twentieth century will be treated from the point of view of a civilization in a constant state of crisis. World War I, the interwar period, World War II, and the attempts to solve the conflicts of modern society after that war in terms of new economic, political, and cultural patterns will represent the core of the study. The effects of extra European influences, the loss of European primacy and continued strife within the structure of the European state and cultural system will receive great emphasis. Mr. Heilbrunner. 3 cr.

71, 72. **HISTORY OF RUSSIA.** The development of the Russian state from its foundation to its present status as a world power. The course is designed to increase the understanding of the present in terms of the past. Political developments, foreign relations, and intellectual and ideological currents. Mr. Heilbrunner. 3 cr.

83, 84. **THE FOREIGN RELATIONS OF THE UNITED STATES.** Primarily the history of American diplomacy, with attention given to the non-diplomatic aspects of foreign relations. Mr. Long. 3 cr.

85, 86. **TWENTIETH-CENTURY AMERICA.** United States history since 1896, from the triumph of industrialism on the national scene to the emergence of America as a world power in the nuclear age. Political, economic, and diplomatic developments. Mr. Greenleaf. 3 cr. (Not offered in 1963-64.)

87, 88. **NINETEENTH-CENTURY AMERICA.** The historical factors, both domestic and international, involved in the development of the American Republic, its institutions and people, from the inception of the new nation in 1789 to the emergence of the United States as a world power in 1900. Mr. Jellison. 3 cr. (87 offered in 1963-64; 88 not offered in 1963-64.)

HISTORY-EDUCATION (HIST-ED). 91. **PROBLEMS IN THE TEACHING OF HIGH SCHOOL HISTORY AND OTHER SOCIAL STUDIES.** Bibliography and new interpretations of history; the social studies curriculum, past and present; aims and objectives in the social studies; selection and organization of teaching material; teaching and testing techniques. Special emphasis on teaching American History and the Problems of American Democracy. Open to students who have satisfactorily completed History 7, 8; six credits in other history courses, exclusive of History 1, 2; six credits from American Government, Principles of Economics or Principles of Sociology; and Principles and Problems of Teaching in the Secondary School. 3 cr.

113, 114. **SOURCES FOR THE STUDY OF COLONIAL AMERICAN HISTORY.** For students who have taken Colonial and Revolutionary American History or the equivalent. Training in the methods of historical investigation and in the use of sources in the field of Colonial American History. The preparation of papers based on source materials alone. Mr. Marston. *Prereq.:* Permission of the instructor. 3 cr.

119, 120. SEMINAR IN MODERN EUROPEAN HISTORY. Specialization in the study of the development of some major institutions and ideas which contributed to the structure and spirit of modern society. Research papers, relating to seminar discussions, will be required. Mr. Gilmore. *Prereq.*: A course in Modern European History and the permission of the instructor. 3 cr.

171, 172. SEMINAR IN RUSSIAN HISTORY. For students who wish to concentrate on specific problems in Russian History, such as the reform movements of the Nineteenth Century, the Russian Revolution, or intellectual movements in Russia. Emphasis will be placed on wide reading, both in primary and secondary works, on discussion of problems and on research papers. Mr. Heilbronner. *Prereq.*: A course in Russian History or in Modern European History and the permission of the instructor. 3 cr. (Not offered in 1963-64.)

185, 186. SEMINAR IN TWENTIETH-CENTURY AMERICAN HISTORY. A specialized and analytical study of movements, institutions, personalities, and problems which have played a shaping role in the development of the United States between 1896 and the middle of the twentieth century. Research papers pertinent to seminar discussions will be required. Mr. Greenleaf. *Prereq.*: A course in United States history and the permission of the instructor. 3 cr. (Alternate years; offered in 1963-64.)

187, 188. SEMINAR IN NINETEENTH CENTURY AMERICAN HISTORY. For students interested in examining in depth certain significant conditions, trends, and aspects of American society during the nineteenth century. Mr. Jellison. *Prereq.*: A course in United States history and the permission of the instructor. 3 cr. (Alternate years; not offered in 1963-64.)

(190), 190. READING AND RESEARCH IN HISTORY. (1) For independent study in an area in which no appropriate course is offered. (2) To be chosen by a graduate student in history who wishes to take courses normally not open to him on a graduate basis. Hours to be arranged. *Prereq.*: Permission of the instructor. 3 cr.

THESIS. 6 cr.

HOME ECONOMICS

MARJORY WYBOURN, *Chairman*

Graduate work is offered leading to the degree of Master of Science in Home Economics with major emphasis in areas which strengthen professional competence in family and community services.

Each student's program will be planned to achieve personal and professional objectives of the individual and will be based on specific interests, ability and undergraduate preparation. Selection of courses from the social sciences and other University departments will be encouraged.

Students admitted to the graduate program in Home Economics are expected to have had an undergraduate degree in Home Economics or a related field. If there are deficiencies in the

undergraduate program students may be admitted on condition that they complete specified prerequisites.

A candidate for a Master of Science degree in Home Economics is expected to fulfill the general requirements of the Graduate School and the following Departmental requirements:

(1) Home Economics—a minimum of 12 semester credits including one course in each of the following two areas: Management and decision-making in the family *and* one in family development.

(2) A minimum of 9 semester credits selected from the liberal arts or other areas which support the major.

(3) Research—a minimum of 4 semester credits including: H. E. 115—Review of Research, *and* H. E. 116—Research Project *or* Thesis.

65. HISTORY OF COSTUME. A broad historical survey of western world costume from primitive times to the present. The influence of social, religious, and political conditions of the eras studied to costume evolution. 3 cr.

67. FUNDAMENTALS OF FASHION. Economic, psychological, and sociological problems inherent in the field of fashion. The development of the fashion industry. 2 cr.

69. ADVANCED TEXTILES. Investigation and evaluation of fabrics in everyday use. Consumption of textiles with emphasis on economic and social implications. *Prereq.*: H.E. 4 or equivalent. 3 cr.

71. EXPERIMENTAL FOODS. Application of the experimental method of study to problems in foods. Methods of evaluating food quality. *Prereq.*: H. E. 18 and permission of instructor. 3 cr. includes lab.

76. NUTRITION SEMINAR. Critical review of literature in the field of nutrition with emphasis on experimental data on which principals of human nutrition are based. *Prereq.*: Permission of instructor. 3 cr.

81, 82. PROJECTS IN CHILD DEVELOPMENT. Discussion conferences and supplementary projects based upon special interests of the student. Work with children in the University Nursery School or in other situations. *Prereq.*: H. E. 26 and permission of the instructor. 1-3 cr.

83, (83). FAMILY DEVELOPMENT. Consideration of relationships and individual growth and development within the home and community at all stages of the family life cycle. Understanding of different cultures and ways of life. 3 cr.

86. FOOD TRENDS AND DEVELOPMENTS. Investigation and evaluation of developments in food production, preparation, and preservation. Instructional field trips constitute a major portion of class time. 4 cr.

87, (87). HOME MANAGEMENT. The management of individual and family resources as related to human needs, values, and goals throughout the life cycle of the family. 3 cr.

96. SEMINAR IN HOME ECONOMICS EDUCATION. Recent developments and problems in teaching home economics at all levels. Individuals or small groups may work on specific problems in the field. *Prereq.*: H. E. 91 or equivalent. 3 cr.

103, 104. **SPECIAL PROBLEMS**—Food and Nutrition. The student, under the guidance of the instructor may select a study, creative project or field experience for independent work in the area of food and nutrition. 3-6 cr.

105, 106. **CURRENT TRENDS IN CLOTHING AND TEXTILES**. The student, under the guidance of the instructor, will undertake selected areas of investigation in the field of clothing and textile. Such investigations may include (a) Philosophy of textiles and clothing in education, (b) Current development of textiles, (c) The textile industry, (d) Social and psychological interpretation of dress, (e) Current research readings in clothing and textiles. 3-6 cr.

115, (115). **REVIEW OF RESEARCH**. Survey, evaluation, and use of research in the field of Home Economics. An introduction to methods and techniques used in defining a problem for study, collecting data, analyzing, and writing a report. 2 cr.

(116), 116. **RESEARCH PROJECT**. A study or project which may be selected in lieu of a thesis. To be taken concurrently with H. E. 115. 2-4 cr. THESIS. 6 cr.

HORTICULTURE

RUSSELL EGGERT, *Acting Chairman*

Students will find the department well equipped for fundamental research on horticultural problems. In addition to the general requirements for all graduate students, basic chemistry and plant science courses equivalent to those ordinarily required for a Bachelor's degree in Horticulture are prerequisites for admission to graduate study in Horticulture.

It is recommended that all graduate students complete work for the Master's degree. For those who wish to continue for the doctorate, in addition to the general requirements for the Ph.D. degree, the student shall satisfy the following departmental requirements:

Foreign Language. The student shall satisfy the Guidance Committee that he possesses a reading knowledge of two foreign languages which may be judged to be useful to him in his field of endeavor, before he may become eligible for candidacy.

Courses Without Credit. The student shall be required to take such courses, without graduate credit, as may be deemed necessary to better enable him to plan and carry out his research and interpret the results. Such requirements must be satisfied *before* the student may become eligible for candidacy.

Minors. One or two minors may be required in fields closely related to the topic of the student's dissertation. A minimum of 6 credits in one department may be accepted as a minor.

53. **ORCHARD FRUITS.** Examination of fundamental principles and experimental data and their applications to orchard problems, including the

establishment of orchards, soil management, water and fertilizer requirements, mineral deficiencies, training and pruning, fruit bud formation, pollination and fruit setting, thinning, and winter injury. Mr. Eggert. 3 lec.; 3 cr.

54. **SMALL FRUITS.** The culture and economic uses of the strawberry, raspberry, blackberry, blueberry, cranberry, and grape. Each fruit is considered with relation to its history, propagation, planting, pruning, harvesting, marketing, insects and diseases, and domestic uses. Mr. Eggert. 3 lec.; 3 cr.

55. **SYSTEMATIC SURVEY OF FRUITS.** Important species and their botanical relationships. The history, distribution, and merits of each species, and the horticultural varieties developed from it. Staff. *Prereq.*: General Botany. 2 lec.; 2 cr. (Offered in 1962-63.)

57. **SYSTEMATIC SURVEY OF VEGETABLES.** Important species of vegetables and culinary herbs and their botanical relationships. The history, distribution, and commercial merit of each species and the horticultural varieties developed from it. 2 lec.; 2 cr. (Offered in 1962-63.)

59. **GREENHOUSE MANAGEMENT.** Modern methods of greenhouse management including soils, watering, costs of production and marketing, and fundamentals of plant behavior under glass. Mr. Rogers. 2 lec.; 1 lab.; 3 cr.

60. **A REVIEW OF HORTICULTURE.** Subject matter covering the principles and practices relating to the culture of fruits, vegetables, and ornamentals. For teachers of Vocational Agriculture and other students with the permission of their advisers. Staff. Summer Session only. Two hours, daily lec. and lab.; 2 cr.

63. **THE DEVELOPMENT OF THE VEGETABLE INDUSTRY.** Similarities and differences in management of vegetable production for fresh market, processing, seed, and roadside sales and home use. The significance of the plant processes of photosynthesis, respiration, and translocation to the vegetable grower. Environmental factors of soil, temperature, and moisture as they affect vegetable production. The management and role of plant growing structures, seed testing, variety selection, nutrition, weed control, and irrigation in the home garden and commercial plantings. 2 lec.; 1 lab.; 3 cr.

64. **THE COMMERCIAL PRODUCTION, STORAGE, AND MARKETING OF SEVERAL DIFFERENT VEGETABLE CROPS.** The management and methods of culture, weed control, insect and disease control, nutrition, irrigation, and marketing of different types of vegetables and in different soils. The use and limitations of specialized equipment and chemicals together with a review of recent experimental work in vegetable production. 2 lec.; 1 lab.; 3 cr.

66. **NURSERY MANAGEMENT.** The development of the nursery business. Factors that influence the location of a nursery, layout of the plant, soil and site, types of plants, pest control, inspection, digging, grading, storage, packing, shipping, and sales. Mr. Eggert. *Prereq.*: Plant Propagation. 1 lec.; 1 lab.; 2 cr.

78. **COMMERCIAL GREENHOUSE CROPS.** A survey of the principal greenhouse crops and an intensive study of their individual culture. Mr. Rogers. *Prereq.*: Greenhouse Management. 2 rec.; 1 lab.; 3 cr.

91, 92. **HORTICULTURE SEMINAR.** A review of current horticultural literature and techniques in horticultural research. Students are required to pre-

pare and present papers on selected topics. Mr. Rogers. This course may be repeated for credit. 1 lec.; 1 cr.

94. PLANT BREEDING. Application of the principles of genetics to practical plant breeding. Hybridization, chemical treatments, and selection as means of producing and improving varieties. Mr. Rogers. *Prereq.*: Zoology 61. 2 lec.; 1 lab.; 3 cr.

95, 96. INVESTIGATIONS, (a) Fruits, (b) Flowers, (c) Vegetables, (d) Ornamentals, (e) Plant Breeding. Elective only upon consultation with Chairman of Department. Mr. Eggert, Mr. Rogers. Elective only after consultation with the instructor in charge. Hours to be arranged. 1 to 4 cr.

101-102. METHODS OF PLANT RESEARCH. A study of the methods used in laboratory and field in plant investigations including scientific equipment such as potentiometers, thermocouples, geiger counters, refractometers, spectrophotometers, etc., and their use; project outlines, bibliographies, procedures, interpretation of data and statistical analysis of results. Mr. Eggert and staff. *Prereq.*: Plant Chemistry. 2 rec.; 2 cr.

103. NUTRITION OF HORTICULTURAL PLANTS. The effect of soil management, fertilizers, mulching materials, and mineral deficiencies on the functioning and performance of horticultural plants. Staff. *Prereq.*: Soils, Plant Chemistry. 2 rec.; 2 cr.

104. ASEXUAL PROPAGATION OF PLANTS. The making, dissection, and critical examination of grafts, buds, cuttings, and layers of clones, especially as applied to fruit stocks. A study of regeneration, orientation, and compatibility of plant tissues. *Prereq.*: Plant Chemistry, Plant Physiology. 2 rec.; 2 cr.

105. FLOWER BUD FORMATION, POLLINATION, AND FRUIT SETTING. The influence of natural environmental factors, soil management, orchard fertilization, and resultant chemical composition of fruit plants on flower bud formation and alternate bearing; also, the effect of these and genetic factors on the production of fruit. Staff. *Prereq.*: Plant Chemistry, General Botany, Genetics. 2 lec.; 1 lab.; 3 cr.

109. INHERITANCE IN HORTICULTURAL PLANTS. Advanced problems in plant breeding and inheritance in various horticultural crops. Special emphasis on linkage and polyploids. *Prereq.*: Elementary genetics and plant breeding. Mr. Rogers. 3 lec.; 3 cr.

125, 126. RESEARCH IN HORTICULTURE. Staff. *Prereq.*: Hort. 102. (May be taken concurrently.) Credits to be arranged.

THESIS. To be arranged.

MATHEMATICS

M. EVANS MUNROE, *Chairman*

The Mathematics Department offers courses leading to two graduate degrees: Master of Science and Master of Science for Teachers.

To be admitted to graduate study for the M.S. degree in Mathematics, a candidate must have satisfactorily completed Mathe-

matics 61-62 (Higher Algebra), Mathematics 67-68 (Real Analysis), or the equivalent of one of these sequences elsewhere. Students planning to do graduate work in mathematics are strongly advised to complete both these sequences as undergraduates. A candidate for the degree of Master of Science in Mathematics who presents only the minimum number (18) of credits in courses numbered 100-149 will be required to present a total of 34 credits for the degree.

Graduate study leading to the M.S. degree in Mathematics is intended to provide a broad and sound training in the fundamentals. The student will, in general, be expected to include in his program courses in analysis, algebra, and geometry. An oral examination will be required of all candidates for the M.S. degree.

To be admitted to graduate study for the M.S.T. degree in Mathematics a candidate must have satisfactorily completed the requirements for secondary school teacher certification in Mathematics. Courses leading to this degree will normally be chosen from those numbered 150-199. Secondary school teachers interested in this degree should consult the Chairman of the Department.

51. METHODS OF APPLIED MATHEMATICS I. Solutions of ordinary differential equations by D-operators, Laplace Transforms, and by series; representation of functions by definite integrals (Gamma, Beta, and error functions); Bessel functions; Fourier Series. *Prereq.*: Math. 24. 3 rec.; 4 cr.

52. METHODS OF APPLIED MATHEMATICS II. Vector analysis (line, surface, and volume integrals); elementary variational techniques; development of some partial differential equations of mathematical physics; solutions of partial differential equations by Laplace transforms and by Green's functions. *Prereq.*: Math. 51. 3 rec.; 4 cr.

53-54. METHODS AND TECHNIQUES OF MODERN COMPUTATION. Methods of numerical analysis which are particularly suitable for high speed computation, including some newly developed methods. Methods for making analytical approximations also will be emphasized. An introduction to programming techniques, assembly and compiler programs, interpretive systems, and symbolic operations. The practical aspects of modern computation, such as loss of precision, round-off error, overflow and underflow, etc., will be illustrated by means of short problems on both the desk calculator and the digital computer in the University's Computation Center. A long range project for investigation on the computer will be assigned. *Prereq.*: Math. 24. 3 rec.; 1 lab.; 4 cr.

55. FUNDAMENTAL CONCEPTS OF GEOMETRY. Systems of postulates of various geometries; geometric invariants; synthetic and analytic projective geometry; introduction to non-Euclidean geometry, topology, and the elementary differential geometry of curves and surfaces. *Prereq.*: Math. 10 or 27. 4 rec.; 4 cr.

56. TOPICS IN NUMBER THEORY. Elementary properties of integers; the Euclidean algorithm; divisibility; diophantine equations of the first degree;

congruences; residue classes and the Euler function; distribution of primes; quadratic residues; diophantine equations of the second degree; selected topics in diophantine approximation and number-theoretic functions. *Prereq.*: Math. 10 or 27. 3 rec.; 4 cr.

61-62. HIGHER ALGEBRA I, II. The integers, the rational, real and complex number systems, congruences, theory of polynomial equations, theory of groups, vector spaces and transformations, matrices and determinants, rings, integral domains, fields, ideal theory, lattices, and Boolean algebras. *Prereq.*: Math. 10 or 27. 4 rec.; 4 cr.

67. REAL ANALYSIS I. The real number system; elements of set theory; theory of limits; continuous functions and their properties; differentiability and the mean value theorem. *Prereq.*: Math. 10 or 27. 4 rec.; 4 cr.

68. REAL ANALYSIS II. The Riemann integral; uniform convergence; double and iterated limits; applications of double limit theorem to series, limits under the integral sign, and existence theorems for differential equations. *Prereq.*: Math. 67. 4 rec.; 4 cr.

81. THEORY OF APPROXIMATION. The theorems of Weierstrass on approximation of continuous functions; the Tschebycheff approximation problem; Tschebycheff polynomials; trigonometric polynomials of best approximation; interpolation; the formulas of Lagrange and Newton, trigonometric interpolation. *Prereq.*: Math. 24. 3 rec.; 4 cr.

82. NON-LINEAR DIFFERENTIAL EQUATIONS. Phase plane analysis of linear systems and non-linear conservative systems; stability theorems; limit cycles and periodic solutions; the Van der Pol equation; the method of Kryloff and Bogoliouboff. *Prereq.*: Math. 24. 3 rec.; 4 cr.

83. INTRODUCTION TO DIFFERENTIAL GEOMETRY. A first course in the metric differential geometry of curves and surfaces in Euclidean space. *Prereq.*: Math. 24. 3 rec.; 4 cr.

84. INTRODUCTION TO TOPOLOGY. Elementary point-set topology in metric and topological spaces, in particular the real line and plane. *Prereq.*: Math. 68. 4 rec.; 4 cr.

88. COMPLEX ANALYSIS. The complex number system; analytical; elementary functions; Cauchy integral theorem and formulas; Taylor and Laurent series; singularities and residues; conformal mapping. *Prereq.*: Math. 24. 4 rec.; 4 cr.

MATHEMATICS-EDUCATION (MATH-Ed) 91. The aims and values of secondary-school mathematics; the recommendations of the national committee on mathematics requirements, and the State Board requirements; the subject matter and the sequence in which it should be presented in both junior and senior high schools; techniques and instructional aids used in teaching secondary-school mathematics; errors, testing program, remedial teaching. Students preparing to teach mathematics in high school should register for this course—it is a prerequisite for Supervised Teaching in Mathematics. Lectures, assigned readings, and discussions. *Prereq.*: Education 58 and Mathematics 10 or 22. 3 rec.; 3 cr. May be counted as major credit only by students preparing to teach mathematics in the secondary schools.

96. INTRODUCTION TO THEORY OF DIFFERENTIAL EQUATIONS. Existence and uniqueness theorems for ordinary differential equations; theory of linear ordinary differential equations of order n ; oscillation and comparison theo-

rems for second order linear ordinary differential equations; first order partial differential equations, linear partial differential equations of the second order. *Prereq.*: Math. 68. 3 rec.; 4 cr.

101-102. FUNCTIONS OF A COMPLEX VARIABLE. Complex numbers; analytic functions; complex integration; representation theorems; thory of residues. *Prereq.*: Math. 67-68 or equivalent. 3 rec.; 3 cr.

103-104. MEASURE AND INTEGRATION. The theory of measure as developed by Lebesgue, Caratheodory and others; the definitions and basic properties of the Lebesgue integral; multiple and iterated integrals; convergence theorems; differentiation of the Lebesgue integral. Related topics will be considered with the choice varying from year to year. Sample supplementary topics; foundations of probability theory, Fourier series, Banach spaces, topological groups and Haar measure, the Daniell integral. *Prereq.*: Math. 67-68 or equivalent. 3 rec.; 3 cr.

106. DIFFERENTIAL GEOMETRY. A second course in the metric differential geometry of curves and surfaces in Euclidean space, with an introduction to tensor analysis and Riemannian geometry. *Prereq.*: Math. 83 or equivalent. 3 rec.; 3 cr.

107-108. MODERN ALGEBRA. Abstract algebra, including theory of rings and ideals; fields and their transcendental and algebraic extensions, valuation theory; Galois theory; algbraic numbers. *Prereq.*: Math. 61-62, or equivalent. 3 rec.; 3 cr.

110. SET THEORY. An axiomatic development of set theory including the theory of cardinal and ordinal numbers. Recommended for all first-year students in M.S. program. 3 rec.; 3 cr.

113-114. MATHEMATICAL STATISTICS. Essentially a mathematical course in the theory of statistics. *Prereq.*: Permission of the instructor. 3 rec.; 3 cr.

115-116. FUNCTIONAL ANALYSIS. Topics in abstract analysis including linear topological and normed spaces with application to the standard function spaces. *Prereq.*: Consent of instructor. 3 rec.; 3 cr.

118. ALGEBRAIC TOPOLOGY. Simplicial complexes and their homology and cohomology groups. Betti Numbers and the Euler-Poincare Characteristic. The singular homology theory. Exactness of the homology sequence. Duality and fixed point theorems. *Prereq.*: Math. 61-62 and 84 or equivalent. 3 rec.; 3 cr.

121-122. ADVANCED APPLIED MATHEMATICS. Methods of applied mathematics such as variational techniques, Green's function techniques and applications of abstract linear operators in addition to the traditional methods for dealing with physical problems. The selection of topics will depend on the interest of the instructor and the students. *Prereq.*: Consent of instructor. 3 rec.; 3 cr.

123-124. PARTIAL DIFFERENTIAL EQUATIONS. First order partial differential equations; geometric significance; Cauchy and Goursat problems; the method of characteristics, classification of linear equations of the second order; elliptic, hyperbolic, and parabolic types; Riemann's method; Green's functions. *Prereq.*: Math. 67-68 or equivalent. 3 rec.; 3 cr.

127-128. THEORY OF ORDINARY DIFFERENTIAL EQUATIONS. Existence and uniqueness theorems for a single equation and for systems of equations; the

linear equations of order n ; linear systems; Sturm-Liouville theory; singularities of autonomous systems; Poincare-Bendixson theory; non-linear differential equations; applications to vibration theory. *Prereq.*: Math. 67-68 or equivalent. 3 rec.; 3 cr.

129. CALCULUS OF VARIATIONS. Classical methods; the first and second variations; Euler's Equation; isoperimetric problems; direct methods, applications to differential equations. *Prereq.*: Math. 67-68 or equivalent. 3 rec.; 3 cr.

131. ALGEBRAIC NUMBER THEORY. Elementary number theory, group theory, arithmetic of algebraic number fields, Dirichlet's theorem on the group of units, finiteness of class number, ramification theory, Fermat's theorem for regular primes. *Prereq.*: *Higher Algebra* (Math. 61-62, or equivalent). 3 rec.; 3 cr.

132. ANALYTIC NUMBER THEORY. Dirichlet series, Abelian and Tauberian theorems, equidistribution of primes in arithmetical progression, special topics. *Prereq.*: Math. 67-68, or equivalent. 3 rec.; 3 cr.

141-142. ADVANCED ANALYSIS. A selection of topics in advanced analysis to meet the needs of second-year graduate students. Content of the course may vary from year to year. *Prereq.*: Consent of instructor. 3 rec.; 3 cr.

143-144. TOPICS IN MODERN ALGEBRA. Content of the course may vary from year to year. *Prereq.*: Consent of instructor. 3 rec.; 3 cr.

145-156. TOPICS IN TOPOLOGY. Content of the course may vary from year to year. *Prereq.*: Consent of instructor. 3 rec.; 3 cr.

NOTE: The following courses are for candidates for the degree of Master of Science for Teachers. Ordinarily they are given either in the Summer Session or as seminars meeting on Saturday mornings.

171-172. FUNDAMENTAL CONCEPTS OF MATHEMATICS FOR TEACHERS. An introduction to the most fundamental concepts of analysis, geometry, and algebra. Basic elements of set theory; a survey of the real and complex number systems; the integers and the concept of an integral domain; introduction to groups; geometrics, Euclidean and non-Euclidean; functions, sequences, and the limit concept; the derivative and the differentiation of algebraic functions. *Prereq.*: Permission of the Department Chairman. 3 cr.

173-174. HIGHER ALGEBRA FOR TEACHERS. The integers, integral domains, and topics from number theory; equivalent relations and congruences; real numbers, complex numbers, and fields; polynomials; group theory; elements of matrix theory; vectors and vector spaces; rings; Boolean algebra. *Prereq.*: Permission of the Department Chairman. 3 cr.

175-176. HIGHER GEOMETRY FOR TEACHERS. Systems of postulates of various geometrics; geometric invariants; synthetic and analytic projective geometry; an introduction to non-Euclidean geometry and topology. *Prereq.*: Permission of the Department Chairman. 3 cr.

177-178. HIGHER ANALYSIS FOR TEACHERS. The real number system; variables, functions, and limits; elements of set theory; numerical sequences and series; continuity; the derivative and the Riemann integral; maxima and minima. *Prereq.*: Permission of the Department Chairman. 3 cr.

179-180. PROBABILITY AND STATISTICS FOR TEACHERS. Permutations and combinations; discrete sample spaces; Markov chains; random variables; de-

scriptive statistics; binomial and normal distributions; goodness of fit; estimation of parameters; testing of hypotheses. *Prereq.*: Permission of Department Chairman. 3 rec.; 3 cr.

185. COMPUTERS AND THEIR USES. A study of computing machines and modern numerical methods. Each student will have an opportunity to make use of the University computer. *Prereq.*: Permission of the Department Chairman. 3 cr.

186. THEORY OF NUMBERS FOR TEACHERS. Divisibility and primes; congruences; quadratic reciprocity; number theoretic functions; Diophantine equations; Farey fractions; algebraic numbers. *Prereq.*: Permission of Department Chairman. 3 cr.

187. THEORY OF SETS AND ELEMENTARY LOGIC. An introduction to set theory and elementary logic. *Prereq.*: Permission of Department Chairman. 3 cr.

188. A MODERN APPROACH TO GEOMETRY. A study of the foundations and development of Euclidean Geometry, with particular emphasis placed upon the recent School Mathematics Study Group's recommendations in the field of high school geometry. *Prereq.*: Permission of Department Chairman. 3 cr.

189. SELECTED TOPICS IN ALGEBRA AND ANALYSIS. A selection of topics in modern algebra and analysis designed to implement the teacher's previous institute training in these fields. *Prereq.*: Permission of Department Chairman. 3 cr.

193. MODERN UNDERGRADUATE MATHEMATICS AND THE HIGH SCHOOL PROGRAM. Selected readings in several of the new college freshman texts as a study of the background now expected of a college freshman. *Prereq.*: Permission of the Department Chairman. 3 cr.

194. TRENDS AND DEVELOPMENTS IN HIGH SCHOOL MATHEMATICS. A detailed study of some of the revised high school curricula now in operation. *Prereq.*: Permission of the Department Chairman. 3 cr.

195. MODERN ALGEBRA AND ANALYSIS IN THE HIGH SCHOOL. Topics in modern algebra and analysis which are currently being introduced in high school curricula, with discussions concerning when and how these topics can best be introduced. *Prereq.*: Permission of Department Chairman. 3 rec.; 3 cr.

196. LINEAR ALGEBRA FOR TEACHERS. The most essential aspects of matrix algebra and determinant theory as simply as possible and in a logical order. It will be given with the objective of preparing the teacher to study the subject intelligently and present it effectively on the high school level. *Prereq.*: Permission of the Department Chairman. 3 rec.; 3 cr.

199. DIRECTED READING AND ESSAY. A directed reading project on a selected topic in mathematics and its applicability to the high school program. The student will prepare an essay upon the topic studied. *Prereq.*: Permission of Department Chairman. 3 cr.

MECHANICAL ENGINEERING

EDWARD T. DONOVAN, *Chairman*

To be admitted to graduate study in Mechanical Engineering a student should have completed work equivalent to that required for a Bachelor of Science degree in this field, at the University of New Hampshire, and should have maintained an average grade of B for his undergraduate course. An oral examination will be required of all candidates for the Master's degree.

55-56. INTERNAL COMBUSTION ENGINES. Thermodynamics applied to spark ignition and compression ignition engines, gas turbines and propulsion motors; fuels, combustion, carburetion, fuel injection, performance. Mr. Stolworthy. *Prereq.*: M. E. 33. 2 rec.; 1 lab.; 3 cr.

57-58. HEAT AND POWER SYSTEMS. Analysis and solution of heat and power system problems, utilizing and developing further the fundamentals of thermodynamics, fluid flow, combustion, and heat transfer. *Prereq.*: M. E. 34, 36 and 38. 3 rec.; 1 lab.; 4 cr.

63. MATERIALS II. Behavior of metals, plastics, and ceramics in engineering environments. Non-equilibrium multiphase relations, diffusion, nucleation of phases, dislocation models of creep and relaxation, ductile and brittle modes of failure, thermal stresses, modification of bulk and surface properties through deformation and heat treating. Laboratory work includes observation of properties by classical mechanical methods. Mr. Hochgraf. *Prereq.*: M. E. 22. 3 lab.; 3 cr.

65. ENGINEERING ECONOMY. The principles which form the basis of engineering procedures for obtaining the highest ratio of utility to cost. Mr. Donovan. 3 rec.; 3 cr.

67. X-RAY METALLOGRAPHY. Theoretical and experimental studies of X-ray diffraction and micro-radiography. Production of x-rays; directions and intensities of diffracted beams; Laue and Debye-Scherrer photographs, size, perfection, and orientation of grains; phase diagram determinations; stress measurement. Mr. Hochgraf. *Prereq.*: M. E. 22 or permission of instructor. 3 lab.; 3 cr.

101, 102. ADVANCED THERMODYNAMICS. The general equations of thermodynamics and their application to fluids such as air, steam, refrigerants, and other working substances; current applications and advances in thermodynamics. Mr. Donovan, Mr. Stolworthy, Mr. Valentine or Mr. Mosberg. 3 rec.; 3 cr.

103. HEAT TRANSFER. The principles of heat transfer processes in engineering. Basic laws of heat transfer. Steady and transient heat conduction. The laws of transfer by radiation. Free and forced convection. Mr. Donovan, Mr. Stolworthy, Mr. Valentine, or Mr. Mosberg. *Prereq.*: Undergraduate Thermodynamics, Fluid Dynamics, D-C Circuit Theory, Calculus, and Differential Equations. 3 rec.; 3 cr.

104. METALLURGICAL THERMODYNAMICS. Entropy and free energy as applied to the solid state. Application of the third law of thermodynamics to order-disorder reactions. The Gibbs-Duhem equation, Hildebrand solubility parameter, and Gibbs Phase rule as applied to homogeneous and heterogene-

ous solid phase equilibrium. Applications in metal and metal-nonmetal systems. Mr. Hochgraf. *Prereq.*: Undergraduate Thermodynamics, Differential Equations. 3 lec. or rec.; 3 cr.

105. **STRENGTH OF MATERIALS.** Strain energy methods, curved bars, beams on elastic foundations, special problems in the bending of beams, thin plates and shells, thick walled cylinders, torsion, membrane analogy, deformations beyond elastic limit, and properties of materials. Mr. Kauppinen or Mr. Norris. *Prereq.*: Elementary Mechanics, Strength of Materials, and Differential Equations. 3 lec.; 3 cr.

106. **THEORY OF ELASTICITY.** This course covers the mathematical theory of elasticity. Plane stress and strain, two dimensional problems in rectangular and polar coordinates, strain energy methods, solution of two-dimensional problems by means of the complex variable, elementary problems in three dimensions, torsion, bending of prismatic bars and axially symmetrical stress distribution problems are treated. Mr. Kauppinen or Mr. Norris. *Prereq.*: Advanced Strength of Material. 3 lec.; 3 cr.

107. **VIBRATIONS.** Linear and non-linear systems; undamped, damped and forced damped systems; electro-mechanical systems and analogies; tabular methods. Mr. Kauppinen or Mr. Norris. *Prereq.*: Elementary Mechanics, Strength of Materials, and Differential Equations. 3 lec.; 3 cr.

108. **THEORETICAL HYDRODYNAMICS.** The mathematical development of frictionless fluid flow using both tensor notation and various coordinate systems. Conformal mapping, Blasius Theorem, Joukowski Hypothesis, hence application of complex variables to two dimensional flow problems such as flow around airfoils. Schwarz-Christoffel theorem and vortex motion. Mr. Mosberg. *Prereq.*: Undergraduate Thermodynamics and Fluid Dynamics, Differential Equations. 3 rec.; 3 cr.

THESIS. To be arranged. 6-8 cr.

MICROBIOLOGY

LAWRENCE W. SLANETZ, *Chairman*

Students admitted to graduate study in Microbiology are expected to have had adequate preparation in the biological and physical sciences and in the basic courses in Microbiology. The candidate for the M.S. degree will be required to complete a thesis and pass an oral examination covering his graduate courses and thesis.

Candidates for the Ph.D. degree must demonstrate proficiency in reading microbiological literature in two foreign languages, usually French and German, must demonstrate to the Doctoral Committee a broad basic knowledge of the field of Microbiology, and must complete a dissertation on some original research in Microbiology.

53. **IMMUNOLOGY AND SEROLOGY.** A consideration of the defensive elements possessed by man and animals which serve to protect them from infectious microorganisms. The principles of serological techniques used in the recognition and identification of biological materials including micro-

organisms. The preparation of vaccines and the production of antisera in animals. Mr. Metcalf. *Prereq.*: Microbiology 8. 2 lec.; 2 lab.; 4 cr.

54. **INDUSTRIAL MICROBIOLOGY.** The isolation, characterization, maintenance, and improvement of microbial species employed in industrial processes. Consideration of pathways of microbial metabolism yielding commercially valuable products; conduct and control of industrial fermentations; techniques for assaying product yield. Mr. Chesbro. *Prereq.*: Microbiology 1 and Organic Chemistry. 2 lec.; 2 lab.; 4 cr.

55, 56. **PROBLEMS IN MICROBIOLOGY.** Special problems, depending upon the training and desire of the student. Elective only upon consultation. Mr. Slanetz and staff. Credits to be arranged.

60. **VIROLOGY.** The animal and plant viruses, including bacteriophages and the rickettsiae; a consideration of techniques for the propagation and recognition of animal viruses; a study of the interactions between virus and host cell and the application to problems of plant or animal infections caused by viruses. Mr. Metcalf. *Prereq.*: Microbiology 53. 1 lec.; 3 lab.; 4 cr.

101. **MICROBIAL PHYSIOLOGY.** Microbial physiology is the study of the means by which microorganisms survive. It deals with the effects of nutritional, chemical, and physical factors on microbial growth; with the generation of activated metabolites during catabolism and the use of these metabolites for the synthesis of macromolecules; with the nongenetic mechanisms directing and regulating cellular metabolism; with the biochemical cytology of the microbial cell; and with evaluatory and ecological relationships among microbial species. Mr. Chesbro. *Prereq.*: Biochemistry (may not be taken concurrently) and Microbiology 1. 2 lec.; 2 lab.; 4 cr.

104. **SYSTEMATIC BACTERIOLOGY.** A study of procedures and methods for the classification of bacteria; review of modern systems of classification. Mr. Slanetz. *Prereq.*: One year of Microbiology. 2 lec.; 1 lab.; 3 cr.

108. **PATHOGENIC AND DIAGNOSTIC MICROBIOLOGY.** A study of the morphological, cultural, biochemical, serological, and pathogenic characteristics of microorganisms causing human and animal diseases. Students will be expected to perform the laboratory procedures for the diagnosis of various infectious diseases. Mr. Metcalf. *Prereq.*: General Microbiology. 2 lec.; 2 lab.; 4 cr.

109, 110. **MICROBIOLOGY SEMINAR.** Reports and discussions on microbiological literature and recent developments in microbiology. Mr. Slanetz and staff. *Prereq.*: Permission of the instructor. 1 rec.; 1 cr.

153. **ADVANCED IMMUNOLOGY AND SEROLOGY.** The theories of infection and immunity; production of vaccines; toxins, and antisera; serological techniques for disease diagnosis and identification of bacteria, including agglutination, precipitin, and complement fixation tests. Students will be assigned special problems on certain phases of the lecture or laboratory work. Mr. Metcalf. *Prereq.*: Pathogenic Microbiology. 2 lec.; 2 lab.; 4 cr.

THESIS. 6-10 cr.

PHYSICS

JOHN A. LOCKWOOD, *Chairman*

For admission to graduate study in Physics the candidate must have satisfactorily completed undergraduate courses in Physics

totaling 24 to 30 semester hours. Suitable undergraduate work in mathematics is essential and must include courses in differential equations and advanced calculus. The aim of the program will be to give the student broad general training in fundamentals. Entering students will be expected to demonstrate proficiency in undergraduate work equivalent to that of the senior year in Physics at the University of New Hampshire. A placement examination, required of entering graduate students, will be given during the fall registration period.

The following courses are required for the Master's degree: Phys. 101-102, 103-104*, 105, 112, and 115. A written examination based upon these courses must be passed by all candidates for the Master's degree.

Candidates for the Master's degree are expected to complete a thesis for 6 credits, and pass an oral examination on the thesis. The department requires one copy of the thesis. Students intending to continue toward a Ph.D. degree may request the permission of the department to waive the thesis requirement for the M.S. degree. Candidates for the Master's degree are expected to demonstrate proficiency in reading physics literature in one language: German, Russian, or French. A minimum of 30 credits is required for the Master's degree.

A candidate for the Ph.D. will demonstrate that he has a broad basic knowledge of the field of Physics by taking both a preliminary and final qualifying examination. The preliminary examination will be the written examination required of all Master's degree candidates. The final qualifying examination will consist of both a written and an oral portion. The Ph.D. candidate will be expected to demonstrate proficiency in languages by passing an examination in German and in either Russian or French. The requirements for the Ph.D. degree (see pages 18-21) and further details can be obtained from the department.

All graduate students must register for Physics 153-154 for two years.

81. PHYSICAL OPTICS. A course which starts with Maxwell's equations and covers the nature of light; interference; diffraction; polarization, and related phenomena. *Prereq.*: Phys. 34, Math. 19 or 24, 3 rec.; 3 cr. (Offered on request.)

82. THERMODYNAMICS. Temperature, work, first and second laws, ideal gases, reversibility and irreversibility, Carnot cycle, entropy, properties of pure substances, thermodynamic applications to pure substances, introduction to the principles of statistical mechanics. *Prereq.*: Phys. 23-24, Math.

* This requirement will be waived if Physics 95-96 or its equivalent has been taken.

19, 20 or 51-52 passed or taken concurrently. 3 rec.; 3 cr. (Offered on request.)

83-84. **ELECTRICITY AND MAGNETISM.** Foundation of electromagnetic theory, including electrostatics, dielectric theory, electromagnetism, magnetic properties of matter, alternating currents, Maxwell's field theory, and an introduction to electrodynamics. 3 lec.; 3 cr.

91. **ATOMIC PHYSICS.** An introduction to atomic physics with considerable emphasis upon the wave mechanical approach. *Prereq.:* Phys. 34, 37. 3 rec.; 3 cr.

92. **NUCLEAR PHYSICS.** Natural radioactivity, nuclear reactions, nuclear scattering, models of the nucleus, high energy nuclear physics, cosmic rays. *Prereq.:* Phys. 91. 3 rec.; 3 cr.

101-102. **MATHEMATICAL PHYSICS.** Differential equations of physics, complex variables, orthogonal functions, variational methods, matrices, vector, and tensor analysis. 3 cr.

103-104. **EXPERIMENTAL PHYSICS.** Introduction to modern experimental research techniques, including discussion and laboratory exercises in fundamental measurements in optics, electromagnetism, nuclear, atomic, and molecular phenomenon. 1, 2, or 3 cr.

105. **STATISTICAL PHYSICS I.** A review of thermodynamics and kinetic theory, followed by an introduction to statistical thermodynamics. *Prereq.:* Phys. 101 or permission of the instructor. 3 cr.

106. **STATISTICAL PHYSICS II.** Basic formulation and application of statistical mechanics to physical problems. *Prereq.:* Phys. 112. 3 cr. (Offered on request.)

107. **MATHEMATICAL PHYSICS.** Formulation and solution of physical problems grouped according to their mathematical properties. *Prereq.:* Phys. 101-102. 3 cr. (Offered on request.)

111. **THEORETICAL MECHANICS.** Particle mechanics, including the motion of rigid bodies, elasticity, fluid dynamics, and special relativity. Particular emphasis is given to topics in classical mechanics that serve as background for the study of modern physical theories. 3 cr.

112. **QUANTUM MECHANICS.** (Non-relativistic). Basic formulation and application, development of approximation methods, and formal scattering theory. Recommended *prereq.:* Phys. 111 and an introductory knowledge of wave mechanics. 3 cr.

115-116. **ELECTROMAGNETIC THEORY.** A course on the formulation and detailed application of electromagnetic theory to physical problems. *Prereq.:* Phys. 101 or permission of the instructor. (116 Offered on request.) 3 cr.

117-118. **ADVANCED QUANTUM MECHANICS.** An extension of Phys. 112 and an introduction to relativistic theory. 3 cr.

119-120. **NUCLEAR PHYSICS.** Formulation of theory underlying current experiments. *Prereq.:* Phys. 112. 3 cr. (Offered on request.)

125-126. **INTRODUCTION TO SOLID STATE PHYSICS.** Development of quantum mechanical theory of solids, transport phenomena, etc. *Prereq.:* Phys. 112 and 105. 3 cr. (Offered on request.)

131-132. PROBLEMS IN THEORETICAL PHYSICS. May be taken more than once. 3 cr. (Offered on request.)

133-134. PROBLEMS IN EXPERIMENTAL PHYSICS. May be taken more than once. 3 cr. (Offered on request.)

149-150. SPECIAL TOPICS. Any special fields of study not covered by the above graduate courses may be included in this course. Choice of topic to be determined by class. 1, 2, or 3 cr. May be taken more than once.

153-154. SEMINAR. Required of all graduate students. Topics to be selected. No credit.

MASTER'S THESIS. 6 cr.

DOCTORAL RESEARCH.

POULTRY SCIENCE

W. C. SKOGLUND, *Chairman*

To be admitted to graduate study in Poultry Science an applicant is expected to have had sufficient undergraduate training in basic sciences to qualify for special work in this field. A thesis is required and a candidate for the Master's degree shall pass an oral examination covering his graduate courses and thesis.

51-52. AVIAN DISEASES. A survey of the diseases of domestic fowl. The first semester, emphasizing the fundamentals of disease control, deals with etiology and diagnosis of bacterial and fungus diseases. A study is also made of the important helminth and protozoan parasites of fowl. The second semester is concerned with those avian diseases caused by viral entities and the nature of their infection. Serological tests, virus isolation, and propagation in avian embryos and tissue cultures will be conducted in the laboratory. Mr. Corbett, Mr. Dunlop, and Mr. Strout. 2 lec.; 1 lab.; 3 cr. (Alternate years; offered in 1963-64.)

53, 54. POULTRY PROBLEMS. Students are given a selection of various problems and are required to compile and present accurate and detailed information in their solution. Staff. 1 to 3 cr.

101-102. AVIAN MICROBIOLOGY. A study of the disease process in the intact host at cellular levels when invaded by viruses or virus-like agents, fungi, and protozoans. Emphasis will be placed on physiological and cytopathological changes in tissue culture. Mr. Dunlop, Mr. Strout, and Mr. Corbett. *Prereq.*: Avian Diseases 52 or the equivalent. 3 cr.

103, 104. ADVANCED POULTRY NUTRITION. A comprehensive study of metabolism and the physiology of digestion with special emphasis on nutrient needs and deficiency diseases of poultry: Analysis of recent experimental research and current feed problems. Mr. Ringrose. 3 lec.; 3 cr.

105, 106. SEMINAR. A survey of recent literature and research in Poultry Science. Mr. Skoglund. 1 cr. per semester.

107, 108. SPECIAL PROBLEMS. The student with the instructor selects a problem. He is then required to outline, organize, and conduct the necessary research, accurately gather and evaluate the pertinent data, and present

the results of the study in a written report. Staff. Hours and credits, not to exceed 3 each semester, are to be arranged.

109, 110. **THESIS.** Hours and credits, from 6 to 10, are to be arranged.

111-112. **AVIAN HISTOPATHOLOGY.** The first semester consists of a course in general histopathology. The second semester will include a discussion of the special histopathology of common diseases with emphasis on tumors and tumor formation. Mr. Dunlop and Mr. Strout. *Prereq.:* Histology or the equivalent. 3 cr.

113, 114. **ADVANCED POULTRY BREEDING.** First semester: Genetic and environmental variation; methods of statistical analysis fundamental to biological research including variance components analysis and principles of partitioning hereditary variance. Second semester: Principles of quantitative inheritance including changes in gene frequency, selection, inbreeding and outbreeding. Methods of estimating heritability and genetic correlations. Mr. Collins. 3 lec.; 3 cr.

PSYCHOLOGY

EUGENE S. MILLS, *Chairman*

In addition to meeting the requirements for entrance into the Graduate School, students admitted to graduate study in Psychology must have had a minimum of 15 credits in undergraduate courses in Psychology. It is desirable that these credits include a course in elementary statistics.

Each graduate student is urged to include some individual work in his program. This can be done by registering for Psychology 172, Graduate Internship; Psychology 181, 182, Reading and Research in Psychology; or Thesis.

A comprehensive written examination is required of all candidates for the Master's degree. An oral examination on the thesis is required of all those who write a thesis. An oral examination may be required of those who do not write a thesis.

Candidates for the Master's degree in Psychology can specialize in one of four areas: General Psychology, Industrial and Personnel, Institutional and Clinical work, and School Counseling. The courses to be taken in each field of specialization will be selected by the student and his supervisor on the basis of his needs, interests, and courses taken earlier. Departments such as Education, Sociology, and Economics will be drawn upon for related course material.

The department has two objectives in its graduate curriculum: the preparation of students for advanced study beyond the Master of Arts in all fields of psychology and for professional work in the applied areas at the Master's level.

54. **PSYCHOPATHOLOGY.** A systematic examination is made of the more severe behavioral disorders as found in the major forms of the neuroses and

psychoses. The ego defense mechanisms and the construct of anxiety are seen as central to the understanding of these disorders. The search for causes, the interpretations of symptoms, and the methods of treatment are considered in detail. Mr. Berger. *Prereq.*: Psych. 47. 3 cr.

57. **EXPERIMENTAL PSYCHOLOGY.** A study of experimental methods in psychology including discussion of theory and practices in applying these methods to a variety of psychological phenomena. Each student in the class will be responsible for an individual experimental project. Mr. Haslerud and Mr. Duryea. *Prereq.*: Psych. 1. 2 lec.; 1 lab.; 3 cr.

58. **PSYCHOLOGY OF LEARNING.** A study of the experimental support for and the practical implications of contemporary theories of learning. Mr. Haslerud. *Prereq.*: Psych. 1. 3 cr.

60. **PSYCHOLOGY OF MOTIVATION.** A study of the drives and motives which underlie normal human behavior and the forms of adjustment which arise when motives conflict or encounter external frustration. Mr. Mills. *Prereq.*: Psych. 1. 3 cr.

63. **DIFFERENTIAL PSYCHOLOGY.** A study of individual differences with special attention given to those who are intellectually gifted or mentally retarded. Mr. Lothrop. *Prereq.*: Psych. 1 or permission of instructor. 3 cr.

67. **STATISTICS IN PSYCHOLOGY.** A study of the problems and methods involved in the statistical treatment of quantitative data in psychology. The computation and interpretation of elementary statistical measures, such as mean, median, standard deviation, and the various methods of correlation are considered in detail. Mr. Duryea. *Prereq.*: Psych. 1. 3 cr.

77. **COMPARATIVE PSYCHOLOGY.** Consideration of similarities and differences in behavior of infra-human organisms at different phylogenetic levels as aids to understanding how behavior evolved and to the clarification of behavior principles. The historical and biological foundations of such special topics as instinct, consciousness, abnormal behavior, social influence, reasoning, and judgment are surveyed by use of the comparative method. Mr. Duryea. *Prereq.*: Psych. 1. 3 cr.

78. **PHYSIOLOGICAL PSYCHOLOGY.** A study of the relation between behavior and the structure of the organism. Special attention to the sensory, nervous, and glandular functions as the organic base for motivation, emotion, learning, etc. Mr. Haslerud. *Prereq.*: Psych. 1. 3 cr.

82. **SOCIAL PSYCHOLOGY OF INDUSTRY.** The exploration of social structure and function of industrial organizations. Emphasis will be placed on leadership, role and organization theories, and a critical evaluation of their supporting experimental evidence. Mr. Kay. *Prereq.*: Psych. 1. 3 cr.

83. **SYSTEMATIC PSYCHOLOGY.** The complex expansion of contemporary psychology as seen in historical perspective. A consideration of some of the major antecedents in philosophy, theology, and the physical sciences. Emphasis is placed on the subsequent extensive development of psychology in the United States in the form of complementary schools and systems of thought and research. Mr. Mills. *Prereq.*: Psych. 1. 3 cr.

89. **MENTAL HYGIENE IN TEACHING.** A study of the fundamental needs of human beings, with special emphasis on the mental and emotional conflicts of secondary-school students arising from the thwarting of these needs. Ways of recognizing these conflicts by their manifestations and of helping students

to resolve them will be treated extensively in the course. Attention will also be given to the mental hazards of the teaching profession. Mr. Jervis. 3 cr. *Not open to students who have completed Psych. 47.*

93. (93). SPECIAL TOPICS IN PSYCHOLOGY. This course will be taught by a different instructor each year. In it the instructor will present advanced material in an area in which he has developed specialized knowledge through research and special study. Students may repeat the course but they may not duplicate areas. Instruction may be given in any one of the following: (a) Clinical, (b) Developmental, (c) Differential, (d) Experimental, (e) Industrial, (f) Learning and Perception, (g) Personality, (h) Physiological, (i) Psychological Evaluation, (j) Psychopathology, (k) Statistics, (l) Systematic. This course does not overlap with Psychology 98, Seminar in Psychology, in which senior majors in psychology write their comprehensive papers. *Prereq.*: 12 semester credits in Psychology and permission of instructor. 3 cr.

95. THE INTEGRATING OF PSYCHOLOGY. By lectures, discussions, and papers senior majors recall and reassess their previous psychology courses, fill gaps in their background, and work on the growing edge of the science. The examination in this course satisfies the departmental requirement of a comprehensive examination. Mr. Haslerud. *Prereq.*: 12 semester credits in Psychology. 3 cr. *Required of all undergraduate majors in Psychology.*

98. HONORS IN PSYCHOLOGY. Open to seniors with a 3.0 average in Psychology courses and the recommendation of a member of the Psychology faculty, or in unusual cases to those who receive special departmental permission. As individuals, or as members of a seminar group, students make library and/or laboratory investigations of problems of mutual interest to professor and student. Oral or written reports will be made by members of the seminar as the basis for discussion. *Prereq.*: 15 semester credits in Psychology. 3 cr.

105-106. INTRODUCTION TO COUNSELING AND PSYCHOTHERAPY. Basic psychological issues are examined to identify similarities and differences among schools of psychotherapy. The components of psychotherapy are explored in terms of theory and empirical research and emphasis is placed upon the development of a theoretical construct for counseling. During the second semester the aims of the course are: (a) to develop an appreciation of the complexities of human behavior; (b) to understand better the difficulties in applying theoretical knowledge to the counseling situation. Case material and role playing will be employed to acquaint the student with the interaction which takes place between the counselor and the client. Mr. Jervis. 3 cr.

108. CASE STUDIES IN COUNSELING. In this course actual cases will be used to reflect a variety of personality theories and counseling techniques. A detailed examination will be made of two individuals in the counseling processes. Other cases will be considered more briefly to explore the interaction of counselor and counselee. The aim of the course is to develop an appreciation of the complexities of human behavior, to gain increased respect for the integrity of individuals and their difficulties in revealing themselves to a counselor, and to understand better the difficulties in applying theoretical knowledge to the counseling situation. 3 cr. (Offered only in summer.)

114. ADVANCED STATISTICS AND EXPERIMENTAL DESIGN. Practice in the set-up of parametric and non-parametric statistical problems commonly

found in the current literature of experimental, clinical, and industrial psychology. Emphasis is placed on understanding the assumptions of the various procedures. Mr. Tempone. *Prereq.*: Psych. 67 or its equivalent. 3 cr.

123. **INDIVIDUAL TESTING.** This course is designed to train students in the administration, scoring, and interpretation of individual tests for the appraisal of intelligence. Such instruments as the Wechsler Adult Intelligence Scale, the Stanford-Binet, and the Wechsler Intelligence Scale for Children will be critically analyzed. Students will be required to purchase one set of test materials. Mr. Berger. *Prereq.*: 15 credits in Psychology or the equivalent in related fields. 1 lec.; 1 lab.; 4 cr.

131. **RESEARCH METHODOLOGY.** An intensive examination of the research process as the attempt to discover answers to meaningful questions through the application of scientific procedures. Attention is focused on the relation of theory to research, experimental design, problems of measurement, techniques for data collection, and interpretation of results. Mr. Kay. 3 cr.

135. **ADVANCED PSYCHOPATHOLOGY.** Special attention will be given to a study and review of the experimental and clinical literature with regard to etiological factors involved in the formation of pathological character trends and deviations. Study will also be directed toward an evaluation of clinical theory and classification systems as related to the psychotherapeutic process. Mr. Berger. *Prereq.*: Psych. 54 and/or permission of the instructor. 3 cr.

141. **PERSONALITY DYNAMICS.** An evaluation of the major theories of personality, especially as they bear upon current research and clinical practice. Authentic case histories, recorded therapy sessions, and empirical studies within the framework of each theoretical position are used as concrete source material. Mr. Tempone. 3 cr.

150. **ADVANCED INDUSTRIAL PSYCHOLOGY.** A survey of the literature on applied experimental psychology; industrial relations; and personnel selection, classification, and training. Attention will be given to the aims, principles, and methods applicable to each of these three areas. Mr. Kay. *Prereq.*: Psych. 32 or its equivalent and Psych. 67 or its equivalent. 3 cr.

162. **PSYCHOLOGY OF PERCEPTION.** A study of the experiments and theories dealing with the fundamental stimulus situation in the internal and external environment. This knowledge of how the organism sees and interprets his world has many applications, e.g., social stimulation, self-regard, and a basis for the projective tests. Mr. Haslerud. 3 cr.

164. **INTRODUCTION TO THE RORSCHACH TEST.** This course is concerned with teaching the administration, scoring, and preliminary interpretation of the Rorschach Inkblot Test. Students will be required to purchase the test materials and to administer and score a minimum of twenty Rorschachs. Klopfer's scoring system will be used for the determinants and Beck's for location. Mr. Berger. 1 lec.; 1 lab.; 4 cr.

172. **GRADUATE INTERNSHIP.** Practical work experience in clinical or industrial psychology. Students will be assigned to institutions or industries and serve under experienced personnel and under supervision of departmental instructors. *Prereq.*: Open to a limited number of graduate students who secure permission of the departmental supervisor. Credits to be arranged up to a maximum of 6.

181, 182. **READING AND RESEARCH IN PSYCHOLOGY.** A student may undertake a course of readings in psychological journals and books or work on an

experiment or other research on some topic acceptable to both student and instructor. The projects are directed by individual conferences. Staff. 3 cr.

THESIS. Open to students who are especially interested in doing independent original research. 6 cr.

SOCIOLOGY

RICHARD S. DEWEY, *Chairman*

Admission to graduate status in the Department of Sociology is granted to the student who meets the entrance requirements of the Graduate School, and who has passed a comprehensive examination in sociology which is prepared by the members of the Department. This examination may be taken, under appropriate supervision, at a time and place which is convenient to the candidate.

In addition to having fulfilled the general requirements, the successful candidate for the Master of Arts degree in Sociology will have completed a thesis written in one of the following fields: criminology, cultural anthropology, mass communications, minority group relations, population, rural sociology, social movements, social stratification, social theory, and urban sociology. It is expected that competence in both method and theory will be demonstrated in the thesis. No more than 9 semester hours' credit in other departments will be accepted. No general oral or written examination is required.

54. **CULTURE CHANGE.** A study of various types of society, leading to the development of a theory of culture change. Assignments include descriptive studies of institutional as well as theoretic materials selected from the writings of Comte, Marx, Spencer, Durkheim, Spengler, Sorokin, Redfield, and others. *Prereq.:* Sociology 1 or consent of instructor. 3 cr.

57. **SOCIAL STRATIFICATION.** Nature, functions, patterns, and effects of social stratification. Social mobility. Special attention is given to the social class system in the United States. *Prereq.:* Sociology 1. 3 cr.

(58) 58. **RACE AND ETHNIC RELATIONS.** Majority-minority group relations. Special attention is given to the nature and results of Negro-White and ethnic group relations in the United States. 3 cr.

62. **SOCIAL MOVEMENTS** The factors related to the original and development of reforms, revolutionary, religious, and other social movements. Generalizations concerning the organization, structure, tactics, and leadership of social movements are described. Consideration is given to the purposes and consequences of selected movements, as well as to the relationships between social movements and social change. *Prereq.:* Soc. 1. 3 cr. (Not offered in 1962-63.)

71. **CRIMINOLOGY.** An analysis of the scientific study and of the control of crime. The following are considered in some detail: indexes, rates and theories of crime and delinquency, police, courts, probation, prison and

parole. The student attends one hour lecture and one hour discussion each week. 3 cr.

73, 74. INTRODUCTION TO SOCIAL WELFARE. Survey of the field of social welfare: history; public welfare; case work; social group work; community organization for social welfare. *Prereq.*: Permission of the instructor. 3 cr.

75, 76. METHODS OF SOCIAL RESEARCH. Analysis of research problems. Designing field studies and experiments. Demonstration and practice in sampling, schedule construction, and interviewing techniques. The first semester will emphasize use of elementary statistical techniques in analysis of prepared data. The second semester will emphasize methods of observation. For Sociology majors and students enrolled in the Social Service Curriculum; others may be admitted by permission of instructor. 3 cr.

88. CRIME CONTROL. A seminar course which deals with the theory and practice of preventing crime and delinquency and of rehabilitating the criminal and the delinquent. There will be a number of lectures by, and discussions with, various penologists. Limited to 15 students. *Prereq.*: Soc. 71. Permission of instructor. 3 cr.

92. FIELDS OF SOCIOLOGY. A consideration of various subject areas of sociology, indicating their growth and development, their relationship to one another, and their current status with regard to research and theory. A discussion of recent developments and the newer subject areas of sociology. Future developments, as extensions of present trends, are discussed. Students not majoring in sociology may be admitted by permission of the instructor. 3 cr.

133. CRIMINOLOGY INTERNSHIP. A four-month, three-quarter time, paid internship in a correctional institution. Consists of various types of routine correctional work and of the execution of small research projects as requested by the director of the prison or reformatory. Opportunity for thesis research in this setting is available. Required for Master of Arts in Sociology with specialization in Criminology. No credit.

151, 152. SPECIAL TOPICS. Under the direction of members of the Department on the basis of rotation and interest, seminars in the following subjects are offered: 1. Communication; 2. Criminology; 3. Culture Change; 4. Culture and Personality; 5. Deviant Behavior; 6. Methods of Research; 7. Population; 8. Rural-urban Sociology; 9. Social Control; 10. Social Differentiation; 11. Sociological Theory. 3 cr.

181, 182. READING AND RESEARCH IN SOCIOLOGY. With the consent of the instructor, a student prepared by training and experience to do independent work may register for a reading and research course. Under the guidance of the instructor, the student will undertake problems and readings in one or more of the following areas: 1. Communication; 2. Criminology; 3. Culture Change; 4. Culture and Personality; 5. Deviant Behavior; 6. Methods of Research; 7. Population; 8. Rural-urban Sociology; 9. Social Control; 10. Social Differentiation; 11. Sociological Theory. Hours and credit to be arranged.

185, 186. DEVELOPMENT OF SOCIOLOGICAL THEORY. A consideration of the development of social thought from Plato to the present. During the first semester the works of selected individuals from Plato to Comte will be examined. Emphasis in the early part of the second semester is on the 19th century European social philosophers, with the remainder of the term centering attention upon the ideas of U. S. social scientists, especially upon

their contributions to present day sociological thought. Students not majoring in Sociology may be admitted by permission of the instructor. 3 cr.

THESIS. Usually 6 cr., but up to 10 cr. when the problem warrants.

ZOOLOGY

GEORGE M. MOORE, *Chairman*

To be admitted to graduate study in Zoology, students must have completed their basic undergraduate preparation in some field of the biological sciences, with at least two years' work in Zoology. Suitable training in botany, chemistry, mathematics, and physics is also necessary. Students lacking these requirements may be admitted but will be required to complete certain courses which do not give graduate credit.

Candidates for the Master's degree in Zoology will be required to pass an oral examination covering their general preparation in the field and their graduate and undergraduate courses in the biological sciences. With the permission of the Department Chairman and the prospective Supervisor of the Thesis, a student may elect to submit a thesis in partial fulfillment of the requirements of the Master's degree. The number of thesis credits will be six.

Students who apply for advancement to candidacy for the Ph.D. degree must (a) demonstrate to the satisfaction of the Guidance Committee proficiency in reading zoological literature of two foreign languages, usually French and German; (b) demonstrate to the Doctoral Committee a broad basic knowledge of the field of Zoology and cognate sciences by means of an oral qualifying examination.

51. PARASITOLOGY. An introductory course on some of the more important parasites causing diseases of man and animals. Living materials will be used as far as possible. Mr. Bullock. *Prereq.*: Biology 2 or 3, and one year of Zoology. 2 lec.; 2 lab.; 4 cr.

52. WILDLIFE PARASITOLOGY. Some of the common helminth and protozoan parasites of local marine, freshwater, and terrestrial vertebrates. Techniques for examination, collection, staining, and identification are included. Mr. Bullock. *Prereq.*: General Zoology. 2 rec.; 2 lab.; 4 cr. (*Offered in Summer only.*)

55, 56. INVERTEBRATE ZOOLOGY. The morphology, phylogeny and natural history of the major invertebrate groups. Staff. *Prereq.*: General Zoology. 2 rec.; 2 lab.; 4 cr.

57. COMPARATIVE PHYSIOLOGY. A survey of the means whereby animals, both vertebrate and invertebrate, have met the problems of irritability, nutrition, maintenance of a constant internal environment, and reproduction. Mr. Lavoie. *Prereq.*: Biol. 2 or 3, one year of Zoology, college Physics and Organic Chemistry. 3 lec.; 1 lab.; 4 cr.

59. **GENERAL PHYSIOLOGY.** The fundamental physiological properties of excitability, contractility, conductivity, metabolism, growth, and reproduction. Mr. Wright. *Prereq.:* Biol. 2, or 3, one year of Zoology, college Physics, and Organic Chemistry. 3 lec.; 1 lab.; 4 cr.

61. **GENETICS.** The physical basis of inheritance, expression, and interaction of the hereditary units, linkage, and variation. The application of Mendelian principles to plant and animal breeding. Mrs. Richardson. *Prereq.:* Biol. 2, or 3, or Bot. 1 and Zool. 48. 3 lec.; 3 cr.

62. **ADVANCED GENETICS.** The recent advances in genetics and cytogenetics. Mrs. Richardson. *Prereq.:* Zool. 61. 2 lec.; 2 lab.; 4 cr.

65. **EMBRYOLOGY.** The fundamental principles of development. The developmental process from the egg to the formation of the body and the establishment of the principal organs and systems. Mr. Staugard. *Prereq.:* Zool. 7. 2 lec.; 2 lab.; 4 cr.

66. **ELEMENTS OF HISTOLOGY AND MICROTECHNIQUE.** The microscopic anatomy of principal tissues and organs of vertebrates with an introduction to general histological technique. Mr. Staugard. *Prereq.:* Zool. 8 or 17. 2 lec.; 2 lab.; 4 cr.

68. **NATURAL HISTORY OF MARINE INVERTEBRATES.** A field and laboratory course aimed at acquainting the student with the inshore marine invertebrate metazoan animals of northern New England. Emphasis will be on identification, classification, habitat preferences, and behavior of these animals. Field work (collections and observation) will constitute a major part of the course. Staff. *Prereq.:* General Zoology. 1 lec.; 3 labs.; 4 cr. (Offered in summer only.)

71. **PRINCIPLES OF ECOLOGY.** The interrelationships of plants and animals with both their living and non-living environments. Attention will be given to energy relationships, limiting factors, community organization, succession, and biogeography. Staff. 3 rec.; 3 cr.

72. **ADVANCED ECOLOGY.** (a) Terrestrial, (b) Freshwater, (c) Marine. An intensive study of the ecology of one of the major habitat areas with the application of general ecological principles and of methods especially applicable to the habitat studied. Staff. *Prereq.:* A course in Principles of Ecology and permission of the instructor. 2 rec.; 2 lab.; 4 cr. Different subdivisions of this course may be taken to a total of not more than 12 credits.

76. **INVERTEBRATE EMBRYOLOGY.** The developmental patterns as exhibited by the major invertebrate groups. This will be essentially a descriptive study based upon lectures, library, and laboratory work with living material. *Prereq.:* General Zoology. 2 rec.; 2 lab.; 4 cr. (Offered in summer only.)

77, 78. **NATURAL HISTORY AND TAXONOMY OF THE VERTEBRATES.** A study of the various classes of vertebrates; their habits, habitats, and life histories with special reference to those occurring in eastern North America. Zool. 77 will include the fishes, amphibia, and reptiles. Zool. 78 will cover the mammals and birds. Mr. Sawyer. *Prereq.:* General Zoology. 2 rec.; 2 lab.; 4 cr.

97, 98. **SPECIAL PROBLEMS.** Advanced students may elect a special problem provided they present a detailed outline of the subject and can furnish adequate proof of their ability to carry it out with equipment available. Mr. Moore and staff. *Prereq.:* Permission of the Department Chairman. 1-4 cr.

111, 112. **ADVANCED STUDY** in (a) Physiology, (b) Embryology, (c) Invertebrate Zoology, (d) Protozoology, (e) Endocrinology, (f) Vertebrate Natural History and Taxonomy, (g) Histology and Histochemistry, (h) Helminthology, (i) Evolution and Genetics. This course provides opportunity for advanced work in the specified areas. Such work will be on an individual or seminar basis and may involve reading, laboratory work, and conferences with the members of the staff concerned. Copies of a formal report or a final examination must be filed with the Department Chairman or the supervising staff member before credit is given for this course. *Prereq.*: Permission of Department Chairman and staff members involved. Staff. 2-6 cr.

151. **PARASITOLOGY.** An introductory course on some of the more important parasites causing disease of man and animals. Living materials will be used as far as possible. This course will meet with Zool. 51. Students are expected to do extra reading and laboratory work. Not open to students who have credit for Zool. 51. Mr. Bullock. *Prereq.*: 8 hours of Zoology. 2 lec.; 2 lab.; 4 cr.

152. **WILDLIFE PARASITOLOGY.** Some of the common helminth and protozoan parasites of local marine, freshwater, and terrestrial vertebrates. Techniques for examination, collection, staining, and identification are included. This course will meet with Zoology 52. Students will be expected to work on a special project in addition to the regular work of the course. Mr. Bullock. *Prereq.*: Introductory course in Parasitology. 2 rec.; 2 lab.; 4 cr. (Offered in summer only.)

155, 156. **INVERTEBRATE ZOOLOGY.** The morphology, phylogeny, and natural history of the major invertebrate groups. This course will meet with Zool. 55, 56. Students are expected to do extra reading and extra laboratory work. Staff. *Prereq.*: General Zoology. 2 rec.; 2 lab.; 4 cr.

157. **COMPARATIVE PHYSIOLOGY.** A survey of means whereby animals, both invertebrate and vertebrate, have met the problems of irritability, nutrition, maintenance of a constant internal environment, and reproduction. This course will meet with Zoology 57. Mr. Lavoie. *Prereq.*: Biology 2, or 3, one year of Zoology, College Physics, Organic Chemistry. 3 lec.; 1 lab.; 4 cr.

159. **GENERAL PHYSIOLOGY.** The fundamental physiological properties of excitability, contractility, conductivity, metabolism, growth, and reproduction. This course will meet with Zool. 59. Students will be expected to do extra reading and laboratory work. Not open to students who have credit for Zool. 59. Mr. Wright. *Prereq.*: Biol. 2, or 3, one year of Zoology, College Physics, and Organic Chemistry. 3 lec. or rec.; 1 lab.; 4 cr.

162. **ADVANCED GENETICS.** The recent advances in genetics and cytogenetics. This course meets concurrently with Zool. 62, but demands additional reading and laboratory work. Not open to students who have credit for Zool. 62. Mrs. Richardson. *Prereq.*: Zool. 61. 2 lec.; 2 lab.; 4 cr.

168. **NATURAL HISTORY OF MARINE INVERTEBRATES** A field and laboratory course aimed at acquainting the student with the inshore marine invertebrate metazoan animals of northern New England. Emphasis will be on identification, classification, habitat preferences and behavior of these animals. Field work (collections and observations) will constitute a major part of the course. This course will meet with Zoology 68. Students are expected to undertake an individual problem extending their knowledge. Mr. Swan. *Prereq.*: General Zoology. 1 lec.; 3 lab.; 4 cr. (Offered in summer only.)

172. **ADVANCED ECOLOGY**, (a) Terrestrial, (b) Freshwater, (c) Marine. An intensive study of the ecology of one of the major habitat areas with the application of general ecological principles and of methods especially applicable to the habitat studied. This course will meet with Zool. 72. Students will be expected to do extra reading and laboratory work. Staff. *Prereq.*: A course in Principles of Ecology and permission of the instructor. 2 rec.; 2 lab.; 4 cr. Different subdivision of this course may be taken to a total of not more than 12 credits.

176. **INVERTEBRATE EMBRYOLOGY**. The developmental patterns as exhibited by the major invertebrate groups. This will be essentially a descriptive study based upon lectures, library, and laboratory work with living material. This course will meet with Zoology 76. Students will be expected to do extra work. *Prereq.*: 12 semester hours of Zoology. 2 rec.; 2 lab.; 4 cr. (Offered in Summer only.)

177, 178. **NATURAL HISTORY AND TAXONOMY OF THE VERTEBRATES**. A study of the various classes of vertebrates; their habits, habitats, and life histories with special reference to those occurring in eastern North America. Zool. 177 will include the fishes, amphibia, and reptiles. Zool. 178 will cover the mammals and birds. This course will meet with Zool. 77, 78. Students will be expected to do extra reading and laboratory work. Mr. Sawyer. *Prereq.*: General Zoology. 2 rec.; 2 lab.; 4 cr.

RESEARCH. Open to students who have declared their intention of proceeding to candidacy for the Ph.D. degree.

M. S. THESIS. Open to students who wish to do independent original research. *Prereq.*: Permission of the Department Chairman and the prospective supervisor. 1-6 cr.

